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The International Congress

Since writing on this great manifestation last week, a number of important events have taken place. On Thursday there were the whole-day works visits to Ipswich, Dagenham and Dunstable, followed in the evening by a reception at the Dorchester Hotel, at which Mr. and Mrs. Lake were the hosts. The participation in the various functions was extremely representative. For instance, the registrations numbered about 640, and no fewer than 500 were present at the Congress Banquet and Mr. Lake's reception. Two hundred took part in the visit to Windsor Castle and the River trip, whilst for the first week of the post-Congress tour a hundred (practically all overseas guests) are participating.

We were only able to be present personally at one technical session—the one held conjointly with the Iron and Steel Institute last Friday afternoon, and we were impressed with the high standard of contributions made by our foreign guests. The rapid and accurate interpretation of their remarks was universally acclaimed, and unquestionably it greatly enhanced the value of the work done. Whilst the various nations regard the technical problems from different angles, it was interesting to learn that the foundry technicians' viewpoints were much the same. For example, there was virtual unanimity as to the usefulness of X-ray and gamma-ray methods as a means of internal control, and the undesirability of their being placed in the category of an acceptance test, with the proviso that they should be used in case of dispute.

The election of Mr. J. Lobstein as President of the International Committee of Foundry Technical Associations will be universally popular. Under existing arrangements he will be the principal guest at next year's International Congress to be held in Milan and Rome during the month of September. The part of the Congress to be held in Milan will be of a purely foundry interest, whilst the second part, held later in Rome, will be in association with the International Congress of Mining, Metallurgy and Applied Geology. Here the metallurgical aspect of foundry practice will be stressed, whilst in Milan the Papers to be presented will be more of a practical character. It has been decided to hold the 1941 Congress in Holland, and that of the following year in the United States.

The visit to Windsor Castle and the trip on the Thames to Bourne End were particularly successful. About half the party were overseas guests. The skies were overcast, but fortunately the rain held off. As we heard some comment on the absence of guides for conducting the party round the State Apartments, it seems desirable to explain that, as some 14,000 persons avail themselves of this privilege each day, serious congestion would result from the hold-up following upon the extra time needed for detailed verbal explanations.

On Sunday the Post-Congress Tour started with a combined rail and motor-coach journey to Birmingham. In this city, and for the whole of the week, there will be a constant round of works visits and informal receptions and dinners. Next week will be spent in Scotland and the North of England.

Looking back over the past week, everybody who took part in the Congress will agree that it proved to be an unqualified success. The timing was excellent, and most functions finished early rather than late. With recollections of previous Congresses and of delegates arriving very late for the evening functions, this adherence to schedule was particularly pleasing and reflects the commendable foresight of the organisers. The social functions were particularly delightful, and appreciative comment was heard on all sides, especially by the ladies, of the pleasure they had derived from participation.

Whilst our own experience does not confirm this, there seemed to be an impression that the general level of discussion at the technical sessions was not on such a high plane as for a purely national convention. This is difficult to explain, but it may be due to an attempt to restrict personal discussion to points which entered the international ambit rather than one's own practice. The very size of the Congress may have induced modesty in a number of individuals. However, there is still an opportunity for the discussion of Papers by correspondence, and those desiring to do this may address their remarks to Mr. Makemson at the office of the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3.

As no opportunity was afforded us of publicly thanking the President of the Congress, Mr. W. B. Lake, for his kindly reference to our work of translating and preparing the Papers for presentation, we would like now to express our gratitude.

The International Congress in London and the Post-Congress Tour

100 DELEGATES VISITING THE MIDLANDS AND NORTH

Our account of the International Foundry Congress in last week's issue of the JOURNAL closed with a report of the banquet, which had been held on the Wednesday evening. The following day was devoted to a series of works visits. Though most of the excursions started between 8 and 9 o'clock in the morning, and the previous evening's function only finished at 1 a.m., there was a surprisingly good attendance. Over fifty people caught the 8.15 a.m. train for Ipswich, where, in addition to visiting the works of Crane, Limited, and E. R. & F. Turner, the delegates were shown some of the town's ancient regalia and records by the Mayor and Town Clerk. An enjoyable luncheon was served at the Aero Club by invitation of Crane, Limited.

The next party left at 8.30 a.m. for Dunstable, and accompanying this party was a number of ladies, who visited the works of Currant & Creek, Limited, hat manufacturers, of Luton. The main party inspected the works of Bagshawe & Company, Limited, of Dunstable, the directors of which were the hosts at a luncheon held under very pleasant conditions at Whipsnade Zoo.

The Dagenham party left Westminster Pier at 8.45 a.m. in m.v. "Royal Princess," this mode of transport providing an excellent opportunity for the delegates to see something of London's dockside activities. Luncheon was served at the Robin Hood Hotel, and tea in the visitors' café at the works, the Ford company being the host on both occasions. In the morning the power house, coke ovens and blast furnace were inspected, and in the afternoon the foundry, machine shops and assembly departments were visited.

For those who had business in London apart from the Congress, two half-day visits were arranged. There was an inspection of the works of Belling & Company, Limited, of Enfield, in the morning, where visitors were shown the complete manufacture of electric cookers from the melting of the metal to the despatch. In the afternoon, there was an inspection of the National Physical Laboratory at Teddington.

The Presidential Reception

After such an energetic day it would have been pardonable had the energies of the delegates flagged during the evening. The reverse was actually the case, and at the reception and dance given by invitation of Mr. and Mrs. Lake in the Ballroom of the Dorchester an air of spontaneous gaiety prevailed right up till 1 a.m. The guests as they arrived were received by the President and his wife, and then took places at the tables grouped beside the dance floor. A really excellent programme of dances had been arranged, and Maurice Winnick's Band provided a perfect accompaniment. With so many of our overseas friends participating, the lilt of the dancers during the waltzes was especially delightful to the eye, whilst they in turn, after a little humorous hesitancy in the early sequences, seemed to become adept at performing the Lambeth Walk. As to the cabaret which was so successful a feature of the evening's entertainment, the "Dorchester Floor Show" proved to be a sparkling and fascinating spectacle, in which the turns were provided by Robert's Alton's "Stars of To-morrow," Miss Kay Kimber, Miss Helen Bennett, Brantley and Linda (dancers), and Naunton Wayne, who not only delighted the company with his "tall stories," but acted as a most urbane *compère* to the show.

It was after the cabaret that Mr. Barrington Hooper, the Master of Ceremonies, called upon Dr. Guido Vanzetti to express the thanks of the guests to Mr. and Mrs. Lake for the wonderful evening which had been arranged. This he did in his characteristically graceful manner, saying that the thoughts of everybody present could be summed up in the two simple words, "Thank you."

The President and his wife were received enthusiastically with musical honours, and in reply Mr. Lake thanked the company for the generous way in which they had responded to Dr. Vanzetti's vote of thanks. There was one thought, he said, which had recurred frequently to him during the Congress. In that room were assembled representaties of all the principal nations of the world, and they had been very happy together. They had spent an enjoyable, peacable and convivial evening, and it was his sincere hope that peace and conviviality would spread through all the world and all the nations and endure for many years to come.

Dancing was then resumed, without any perceptible dwindling of numbers, until 1 a.m., when this very happy function ended.

Friday's Sessions

During the morning two sessions were held, one being presided over by the President and the second by Mr. D. H. Wood, the newly-elected Vice-President. Altogether fourteen Papers were presented. During the morning there was a meeting of the International Committee of Foundry Technical Associations, presided over by Dr. Guido Vanzetti. Those present were Mr. J. Léonard and Mr. R. Deprez (Belgium); Prof. Pisek (Czecho-Slovakia); Mr. A. Brizon and Mr. J. Lobstein (France); Prof. Piwowarsky (Germany); Mr. W. B. Lake and Mr. V. C. Faulkner (Great Britain); Mr. F. W. E. Spies and Dr. K. J. Van Nieukerken (Holland); Mr. R. Erdos (Hungary); Mr. M. Barigozzi and Dr. Raoul Dupuis (Italy); Mr. L. Brasseur (Luxembourg); Prof. K. Gierdziejewski and Mr. J. Lutoslawski (Poland); Mr. A. R. Bean, Dr. H. A. Schwartz and Mr. V. Delport (U.S.A.). The subjects discussed included finance; the international foundry dictionary; international standardisation; and theory of runners and risers, about which Poland is collecting data. Mr. J. Lobstein was unanimously elected President, and Hungary was invited to nominate a Vice-President. A very cordial invitation was extended by Dr. Vanzetti for the 1940 Congress to be held during the month of September in Milan and Rome. The first part of the meeting is to be of a purely foundry character, and such matters as the application of the electric furnace in foundry practice and foundry mechanisation are to be the main topics for discussion. The second part, to be held in Rome, will be a joint meeting with the International Congress of Mining, Metallurgy and Applied Geology, and subjects of a metallurgical character will be submitted. It was decided that the 1941 Congress be held in Holland and that of 1942 in the United States of America.

Following the meeting, the whole of the Committee proceeded to the Tomb of the Unknown Warrior in Westminster Abbey, where, after a short service conducted by a Canon of the Abbey, Dr. Vanzetti laid a wreath on the tomb on behalf of the Committee. The simplicity and sincerity of the ceremony will leave a lasting impression on all the participants.

On returning to the Dorchester, the Committee representatives and their ladies were the guests of Dr. and Signora Vanzetti for luncheon. In a very gracious speech Mr. Lobstein expressed the thanks of the guests.

The Steel Session

The President was accompanied at the tribunal by Dr. Vanzetti, Dr. Desch and Mr. K. Headlam-Morley at the afternoon session, which was held conjointly with the Iron and Steel Institute.

In order to conform with an excellent Continental system, there was a short closing session, at which Mr. Lake took the opportunity to thank all those who had contributed to the success of the Congress.

The Excursion to Windsor and the Thames River Trip

About 200 delegates presented themselves at Paddington Station on Saturday morning for a day's excursion, first to Windsor Castle and by steamer up the River Thames to Bourne End. On arrival at the Castle a halt was called to witness the Changing of the Guard. Two parties were formed, and as the second one contained most of the French-speaking visitors, Mr. Delport acted as interpreter. Luncheon was taken at the Castle Hotel, and immediately afterwards the steamer "Cliveden" cast off for a leisurely journey up the river. The part of the river between Windsor and Bourne End is considered to include the most picturesque reaches. There was a good deal of good humoured clowning, and a Polish delegate provided some really excellent music. The weather just managed to remain rainless, and the party returned to London well pleased with their day's outing.

POST-CONGRESS TOUR

A popular and much appreciated feature of all International Foundry Congresses is usually a tour of the industrial and also the picturesque areas of the country in which the Congress is held. A most comprehensive tour of two-weeks' duration has been organised to follow the Congress held last week in London, with the active co-operation of a number of Branches of the Institute of British Foundrymen, and the first week at least of this tour has proved to be surprisingly and almost embarrassingly successful.

Practically 100 members of the Congress left Paddington Station on the first stage of the tour last Sunday morning. No fewer than seventeen nationalities were represented, and the party will be accompanied throughout by Mr. W. B. Lake (President of the Institute of British Foundrymen), Mr. Tom Makemson (Secretary), and three representatives of Messrs. Thomas Cook & Son, who are responsible for the travel and hotel arrangements under the direction of Mr. Makemson.

The party detrained at Banbury and proceeded by motor-coach *via* Sulgrave Manor, the birthplace of George Washington, to Leamington, where a halt was made for lunch. In the afternoon the excursion was continued to Kenilworth, Warwick and Stratford-on-Avon to Birmingham, which was reached slightly ahead of the scheduled time of 7.0 p.m. The Birmingham Branch of the Institute of British Foundrymen gave the visitors a really hearty welcome, and members and ladies of the Branch helped them to spend a very happy and almost hilarious informal evening. Mr. A. Tipper (the Branch-President) welcomed the party in English, French and German, but forgot to address the Polish and Japanese members in their native languages; with a little more persuasion it is probable that he would have tried to do this also.

Works Visits to Birmingham

On Monday morning, June 19, the gentlemen visited the enormous works of the Austin Motor Company. Most of the time was spent in the foundries, to the delight of the visitors, who were most impressed by the wonderful example of a large mechanised foundry. Mr. G. W. Brown, Mr. Sheehan, Mr. Duncan Brown and their staffs had obviously given much thought

(*Continued on page* 554.)

Relationship Between the Quality of Iron and Steel Castings and the Nature of Materials of the Melt*

By Dr.-Ing. P. BARDENHEUER†

The most important conditions for the production of sound castings of high quality in the iron and steel foundry are the use of satisfactory materials for the melt and their appropriate and correct metallurgical treatment during the melting process. Until a few years ago, the means available for examining the quality of the raw materials were still inadequate, and the metallurgical processes taking place during the melting operation had likewise not been investigated to any great extent. It was often found that certain materials, for instance, foundry pig, despite satisfactory chemical composition and satisfactory melting conditions, produced castings which were of unsatisfactory quality in many respects, while the same pig-iron from another source, but with the same composition and melting conditions, resulted in good castings in every respect.

Only the development of suitable analytical methods for determining the gases and oxides in iron and its alloys has provided metallurgists with valuable means for examining the raw materials and products from fresh points of view and elucidating the influence of the gases and oxides on the quality of the products. At the same time, on this basis, ways and means have been discovered for eliminating the previously unexplained defects of the materials, and, in addition, for investigating and improving the processes for the production of iron and steel. Particularly in connection with steel production, very considerable progress has thus been made, but the new knowledge has not been applied to very great advantage in regard to the metallurgical problems of the iron and steel foundry. The following remarks are intended to provide a contribution to the elucidation of the relationships between the nature of the materials of the melt, their metallurgical treatment during melting and the quality of the products.

Characteristics of Defects caused in Ferrous Castings by Gases and Oxides

Considerable difficulties may be produced in iron and steel foundries by gases which have either been dissolved in the molten metal or have been formed by reaction. Apart from the occurrence of blowholes which are formed during solidification, and which in many cases render the casting useless, gases which only separate out after solidification may impair the mechanical properties of the material without any visible defects showing in the casting. Hydrogen and nitrogen are the most important of the dissolved gases, while carbon monoxide formed by the reaction of carbon with oxides is the principal reaction gas.

The *dissolved gases* are either already present in the materials of the melt or are absorbed during remelting. Their behaviour in relation to the temperature is best shown by the solubility curve of hydrogen in iron. Fig. 1 shows this curve according to Sieverts.[1] The solubility increases with the temperature up to the melting point, when it increases suddenly to about twice the value and then increases slowly again in the liquid phase, although more rapidly than in the solid phase. Nitrogen behaves quite similarly. In most types of steel and foundry iron, the solubility conditions are fundamentally the same as in pure iron.

The molten metal is thus capable of absorbing very considerable quantities of gas, and on cooling it gives off the gases again in accordance with the same law. If the molten metal was saturated with gases, then during the solidification of the metal in the mould, considerable quantities of gas are liberated in accordance with the steeply falling solubility curve, and are capable of forming blowholes in the casting.

The same defects may also be formed by *reaction gases*. The latter often initiate the separation of dissolved gases which, despite the saturation of the metal, and without this stimulation by reaction gases, would have remained in solution until after the solidification of the metal. In the operation known as "killing" the steel, the very reactive oxides, ferrous oxide and manganous oxide, are converted into silica or very unreactive silicates by the addition of silicon, any formation or separation of gas being suppressed in most cases. A corresponding effect is produced by the addition of aluminium.

The deterioration of the mechanical properties by dissolved gases is less known than the obviously perceptible defects caused by blowholes. If a liquid steel has absorbed so much hydrogen that, upon cooling, the saturation value is only attained after solidification is ended, then, as the temperature falls, hydrogen separates out in accordance with the diminishing solubility. It might be assumed that this

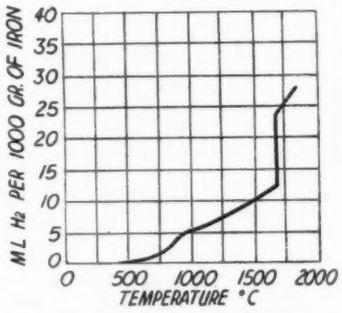

FIG. 1.—SOLUBILITY OF HYDROGEN IN IRON IN RELATION TO TEMPERATURE. (SIEVERTS.)

gas would escape from the material without any harmful consequences, but conditions are rather different.

The hydrogen is dissolved in the atomic form in the iron. In this form, it is able to diffuse through iron unimpeded even at room temperature. If, however, during the cooling of the iron, the crystal is no longer able to keep the hydrogen in solution, owing to the diminished solubility, and on its way to the surface the hydrogen comes to a grain boundary or some other free place in the steel or a non-metallic inclusion, two hydrogen atoms combine to form a molecule. Molecular hydrogen is insoluble in steel, and is no longer able to escape from it by diffusion. It collects in narrow cavities under high pressure, as may be observed in the case of blister formation in pickling.

This process is illustrated by the following simple experiment.[2] A mild steel rod about 200 mm. (8 in.) long was provided at one end with an axial bore tightly closed by a pressure gauge. Atomic hydrogen was liberated on the surface by electrolytic pickling and diffused in that form into the steel. In the bore, however, it was converted into molecular hydrogen to which the steel was impervious. The pressure of the molecular hydrogen in the bore increased very rapidly, and at 300 atm. the experiment had to be discontinued. In an exactly similar manner, hydrogen separated from the iron crystal in consequence of the reduction in solubility can very rapidly accumulate on the grain boundaries under pressures of many thousand atmospheres. It produces considerable stresses in the material and can make its way to the outside only with the destruction of the structure. At elevated temperatures, the hydrogen also reacts with the oxides, sulphides, carbides, etc., forming the corresponding hydrogen compounds, which are also insoluble in steel, and are therefore unable to diffuse, so that they produce the same defects as molecular hydrogen.

According to investigations by Houdremont and Korschan[3] and by Bennek, Schenk and Müller,[4] flakiness in steels is to be attributed to local accumulations of hydrogen under high pressure.

Korber and Mehovar,[5] after heating freshly rolled rails for one hour at 200 to 600 deg. C., or even after long storage, found a very considerable increase in the elongation and reduction in area in the tensile test. The cause of this improvement can only be the expulsion of hydrogen. This was confirmed by further experiments with freshly rolled rails,[6] in which the hydrogen content fell from 2.13 to 0.1 ml. per 100 grams, both after heating for one hour at 200 deg. C. and after storing the tensile test specimens for seven weeks at room temperature. At the same time, the elongation in the tensile test increased by about 50 per cent. and the contraction in area by about 100 per cent. In similar experiments, Drescher and Schäfer,[7] in the case of cast steel of a tensile strength of about 60 kg. per sq. mm., found that heating for 60 hours at 100 deg. C. resulted in an increase in the elongation from 7 to 24 per cent. and in the contraction from 8 to 36 per cent.

Ageing of Castings

It is often observed that machine parts of grey iron or cast steel are distorted when they have been at the working temperature for some time. Experienced practical men, without being aware of the causes, often prevent this by keeping the parts in storage for a considerable length of time, often a whole year, before machining. Others expose the castings in drying chambers for one or more days to a temperature of about 200 deg. C. In all cases, the result of the treatment is that the castings, after machining, no longer warp in service for the reason that the gases held in the material under high pressure have been expelled, thereby equalising the strain.

Various difficulties in the vitreous enamelling of grey iron castings and steel may be attributed to the gases remaining under high pressure in the casting.

All these experiments and observations show that the gases left in the castings after solidification greatly impair the mechanical properties of the material and can lead to appreciable trouble. Even though similar investigations have not yet been made on other cast metals, it may be concluded from extensive works experience that also the quality of these metals may be detrimentally affected by hydrogen in the same way.

After this general account of the characteristics of the defects produced by gases and oxides in cast products, it is intended to deal in what follows with the problem as to how the gases and oxides find their way into the cast metal and how the defects caused by them may be prevented.

Gases and Oxides in Pig-iron

Until the threshold of the previous century, the greater proportion of iron castings were made directly from the blast furnace, and this method of working was also retained long after the introduction of the cupola furnace. As the production of the blast furnace came to be increased more and more by increasing the height, blast pressure and furnace temperature, serious difficulties arose through the numerous faulty castings caused by blowholes, and consequently this method of working had gradually to be abandoned entirely. After the solidification of the iron in the pig bed and remelting in the cupola or reverberatory furnace, the behaviour of the iron was satisfactory.

Even after this treatment, however, the iron often produced defective castings as the development of blast-furnace smelting proceeded in the

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* Paper read to the International Foundry Congress in London.
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above direction, particularly when the blast-furnace output began to be increased by artificially increasing the burden by large quantities of scrap. Of the English specialists in particular, Fletcher[8] has pointed to the difficulties caused in this way in the iron foundry.

Moldenke,[9] the well-known American foundryman, has dealt very exhaustively with this problem. He cited cases in which so much scrap was added to the burden that the blast furnaces became cupolas. A saving in coke of 30 per cent. and an increase in output of 60 per cent. were certainly attained, but when this pig was used in the foundry, the complaints regarding porous castings became very insistent.

The literature shows that serious efforts have been made in many quarters to explain and remove the difficulties, but up till now the results have not been wholly successful, evidently because it has been impossible to gain a complete picture of the more deeply-lying causes.

According to the present knowledge of the processes taking place in the blast furnace, the iron is already completely alloyed with carbon, silicon, manganese and phosphorus when it reaches

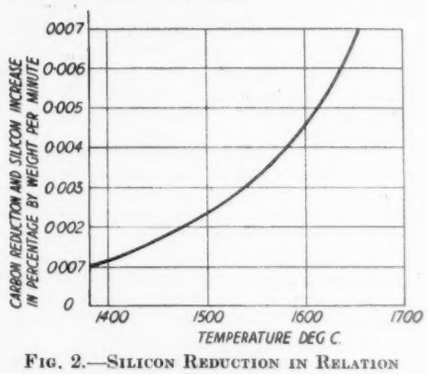

FIG. 2.—SILICON REDUCTION IN RELATION TO THE TEMPERATURE.

the hottest zone of the furnace in front of the tuyeres. During its passage through this zone it is subjected to intense oxidation. In addition to considerable amounts of iron, the alloying elements which have the greatest affinity for oxygen, above all silicon and manganese, are affected by the oxidation. As shown experimentally by Wüst,[10] a foundry iron has much higher silicon and manganese contents above the tuyeres than the iron when tapped.

The iron together with oxides of iron and its accompanying elements and slag thus trickle from the plane of the tuyeres down into the hearth, where, as in the hearth type of furnace, the molten iron is covered by a layer of slag. The slag has the important function of retaining the oxides which descend with the iron. The separation of the oxides from the metal is more complete, the lower the content of these oxides in the slag and the thicker the layer of slag. If, however, when employing a high-iron burden —for instance, when the burden is enriched with scrap—the layer of slag is only very thin, it may easily happen that the concentration of oxides in the small quantity of slag becomes so great that further absorption of oxides is rendered difficult. Also, even when the slag has not yet reached saturation, the absorption of oxides is rendered difficult when the path of the oxide-containing iron alloy through the layer of slag is only very short. The complete removal of the slag during casting has particularly unfavourable consequences, because for the first period the iron is not covered with slag at all. In such cases, therefore, oxides of iron, silicon and manganese can pass into the molten iron. In an iron containing silicon and manganese, the oxygen passes over to these elements and iron and manganese silicates are mainly formed.

As shown by Fig. 2, the reduction of silica by carbon, which even at 1,400 deg. C. already proceeds at an appreciable velocity, increases rapidly with rising temperature. Manganese silicates in particular are very difficult to reduce. If the conditions in the iron bath are not very favourable for the reduction of these oxides by the carbon, either because the temperature is not very high or the time before tapping is too short, the reaction of the carbon with these oxides continues after tapping.

With falling temperature, the conditions become increasingly unfavourable towards this reaction so that it soon ceases and cannot proceed to the end. As a rule, cavities in the pigs imply that the evolution of gas has continued up to the solidification of the iron. In the case of foundry pig, the reaction between the oxides retained in the iron and the carbon, which reaction has not been completed in the hearth of the blast furnace and in the pig bed, may also continue after the remelting of the iron in the cupola until solidification in the mould, thus resulting in the production of castings with cavities. A foundry pig produced from a low-iron burden, that is to say with an abundant quantity of slag, exhibits a perfectly quiet behaviour both during solidification of the pig and also in the casting after remelting in the cupola.

Unsatisfactory behaviour is often observed particularly in the case of high-silicon foundry pig. This is very probably on account of the fact that the pig has been killed by silicon in a similar manner to steel. Even though the carbon content of pig-iron is much higher than that of steel, the silicon content is also higher and the temperature lower. Thus, in the hearth of a blast furnace, a pig which has a certain carbon content, and boils vigorously with a low silicon content, can be killed by increasing the silicon content so that it no longer boils, similar to the behaviour of molten steel.

If a high-silicon iron lies quietly in the hearth on account of the absence of any boiling movement, the equalisation of concentration within the metal bath is rendered very difficult, so that, within narrowly limited reaction zones, a stationary condition between the oxides and carbon of the bath is very soon attained and further reaction no longer takes place. Reaction can only continue upon casting when mechanical mixing of the iron occurs, and this resumption of the reaction is favoured by the fact that upon casting an additional oxidation takes place through the molten metal coming into contact with the air. The same can occur after remelting. Thus, whereas a low-silicon iron can boil vigorously in the hearth of the furnace, the oxides being reduced as far as a certain condition of equilibrium, it is possible, in an iron killed by a higher silicon content, for a considerably greater quantity of oxides to be left, in consequence of the incomplete equalisation of concentration, and then such oxides only react during and after casting or after remelting.

The oxide content of the pig is comparatively low, but it must be remembered that even very low oxygen contents can exert a decided influence on the behaviour of the pig, since in the reaction of only 0.001 per cent. of oxygen with the carbon which is always present in excess, the volume of carbon monoxide formed is about 40 per cent. of that of the iron at 1,100 deg. C.

In addition, the formation of reaction gases in the molten iron before and during solidification initiates the liberation of the dissolved gases. As in the case of the killing of steel by silicon or aluminium, dissolved gases may remain in solution in iron, despite supersaturation, provided no reaction gases are formed.

For removing the dissolved gases from the iron, it is advantageous that the bath in the hearth of the blast furnace should boil. As is well known, boiling is due to the reaction of the metal oxides with carbon to form carbon monoxide, which is insoluble even in iron. The bubbles of carbon monoxide produce in the metal itself and on its surface an atmosphere of carbon monoxide, in which the hydrogen and nitrogen pressure is equal to zero, so that the partial pressure of these gases in the metal bath tends to equalise with the lower pressure of the same gases in the surrounding atmosphere, the dissolved gases being thus gradually removed from the bath.

The process of the expulsion of dissolved gases from the metal bath is illustrated by the following experiment. Carbon dioxide was passed for 30 minutes into two identical vessels filled with distilled water. Then air free from carbon dioxide was passed through the water in one of the vessels, while the second vessel was allowed to stand quietly in the air. A sample was taken from both every ten minutes and the carbon dioxide content determined in it. The result is shown in Fig. 3. The air which was blown through had gradually removed almost all the carbon dioxide from the water within an hour, while the carbon dioxide content of the water in the second vessel was maintained during that time.

Vigorous boiling of the bath is thus the only possible means of removing gas from the iron in the hearth of the blast furnace. If the silicon content be so high that, with the given composition and temperature, the iron bath is killed, there is practically no evolution of dissolved gases. It must furthermore be borne in mind

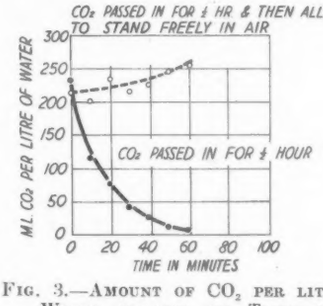

FIG. 3.—AMOUNT OF CO_2 PER LITRE OF WATER RELATED TO TIME DURING WHICH AIR WAS BLOWN THROUGH OR THE WATER ALLOWED TO STAND.

that if the iron is to have a high silicon content, the blast furnace should be operated at a correspondingly higher temperature, and as the solubility of gases in iron increases with the temperature, this is an additional reason for generally expecting that the gas content of the iron will be higher with increasing silicon content.

The Behaviour of Gases and Oxides in the Remelting of Pig-Iron and Steel

The slow solidification of the iron in the pig bed has the advantage that the greater portion of the dissolved gases escapes from the iron. Another portion may escape during storage. During remelting, the dissolved gases are given off more completely by the iron, the slower the rate of heating, and the lower the content of the furnace atmosphere in the gases which are to be removed. In this respect the reverberatory furnace and still more so the crucible furnace are to be preferred to the cupola.

During remelting with access of the furnace atmosphere, it is always necessary to take into account the possibility that the iron will absorb gases therefrom, particularly hydrogen, when it is exposed to that atmosphere for a considerable time at a high temperature or even in the molten state. In a slow-melting cupola, the molten material may become so saturated with gases as to produce porous castings. A high gas absorption is observed in particular when, in consequence of low tuyeres, the molten iron in the hearth of the furnace is exposed to an intense current of blast.

The oxides left in a finely divided condition in the pig-iron after solidification cannot be entirely removed therefrom during remelting in the cupola either by mechanical separation or by chemical reaction with the carbon, because the time elapsing from melting to pouring is insufficient for that purpose. In many cases, the reaction still continues in the casting ladle and in the mould, so that defective castings are

unavoidable. The oxides formed in the furnace on the surface of the charge may, on the contrary, accumulate in the slag, but if the blast entering the furnace from the tuyeres impinges at too high a velocity on the iron so that the latter is vigorously whirled up or even formed into spray, it is conceivable that there will be a greater additional absorption of oxides.

The absorption of gases and oxides during melting in the cupola is limited to a minimum if the melting operation is accelerated as much as possible by blowing sufficient amounts of combustion air through tuyeres of adequate size and well distributed over the furnace cross-section.

In reverberatory furnaces, the iron charged melts more slowly. If the furnace atmosphere be

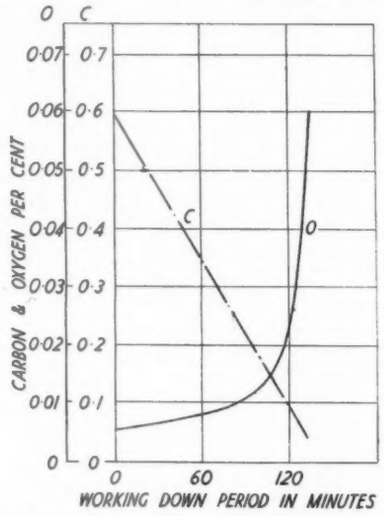

FIG. 4.—CARBON AND OXYGEN CONTENTS RELATED TO WORKING-DOWN PERIOD.

favourable, a gas-containing iron can give off more gas than it absorbs. As soon as it is melted and its dissolving capacity for gases has increased considerably, it is removed from any further action by the furnace gases by the fact that it sinks below the covering of slag. The oxides and particles of slag are able to separate from the molten metal in the usually long time elapsing before the bath has reached the necessary casting temperature, provided they are not reduced by the carbon. Consequently, when the melting operation is properly conducted, it is easier to produce satisfactory castings from a reverberatory furnace than from a cupola.

For the production of steel castings from the reverberatory furnace, the working conditions to be observed are the same as those known for the production of steel in the Siemens furnace. The charge generally consists of a small proportion of pig and a large proportion of scrap. In the open-hearth process, the melter has always considered it of great importance to ensure that, after melting, the steel still contains so much carbon that the bath is able to boil vigorously for a certain time until the desired carbon content has been attained in the molten metal, because if this requirement be not satisfied, the steel does not merely cause difficulties through considerable evolution or separation of gas during solidification, but it also has poor technical and mechanical properties.

From present knowledge of the open-hearth process, carbon is the most powerful and most effective deoxidiser. According to the equilibrium relationships between carbon and oxygen in the steel bath, only very little oxygen is stable in the presence of a high carbon content, but the more the carbon is removed from the bath by decarburisation, the greater is the quantity of oxygen which can be absorbed by the steel in the form of ferrous oxide. The theoretical variation of the oxygen content in the steel bath with the carbon content during an open-hearth melt is shown in Fig. 4 on the basis of the equilibria determined by Vacher and Hamilton.[11] A decarburisation of from 0.6 per cent. to about 0.05 per cent. at a rate of about 0.25 per cent. carbon per hr. has been taken as basis. This diagram shows that the carbon content of the bath, as long as it is present in adequate concentration and can react, is the primary deciding factor for the oxygen concentration. As more carbon disappears from the bath, so more oxygen passes into the bath from a slag rich in ferrous oxide. In the case of a low carbon content of the bath, therefore, the oxygen content of the bath can be kept low only under a slag which is poor in ferrous oxide. The diagram in Fig. 4, however, also shows the advantage of "catching" the carbon in open-hearth melting. For instance, a steel caught with 0.25 per cent. C would contain somewhat less than 0.01 per cent. O in the case of equilibrium according to the curve. If, however, the same melt was decarburised down to about 0.05 per cent. C and recarburised subsequently, it would absorb very considerable amounts of oxygen, which under ordinary conditions could be removed from the bath again only to a small extent by the carbon subsequently added. It is not possible to rely upon the removal of oxygen by the subsequent addition of deoxidisers (for instance, manganese or silicon), because the oxygen is not removed directly by these additions, but is merely converted into another chemical compound. The total oxygen content may be even slightly increased by these additions. In any case, however, keeping the oxides away from the bath is always more satisfactory and reliable than any measure for their subsequent removal.

The boiling of the steel bath has the important function of removing the dissolved gases. This process has already been fully dealt with in discussing the production of pig-iron. For instance, according to the author's investigations, the high nitrogen content of basic-Bessemer steel which is charged molten into the open-hearth furnace in the duplex process falls to about one-third of its original value after a short boiling. Vigorous and sufficiently long boiling of the steel is particularly essential when the charge contains much rusty scrap. As is well known, iron rust differs from the pure oxides of iron by its content of chemically-combined hydrogen. It should be borne in mind that through 1 per cent.

TABLE I.—*Gas Content of Steelmaking Additions.*

	O_2. Per cent.	H_2. Ml. per 100 g.	Total gas. Ml. per 100 g.
Nickel	0.035	30.0	86.1
Chromium metal ..	0.045	7.60	200.0
" " ..	0.011	5.45	56.9
Tungsten powder ..	0.45	52.4	793.3
Cobalt metal ..	0.13	3.30	183.5
" " ..	0.032	2.36	52.9
Ferro-chromium ..	0.063	1.83	103.0
" ..	0.014	1.99	25.1
Ferro-tungsten ..	0.046	7.6	75.4
" ..	0.031	3.1	46.8
" ..	0.030	6.7	46.1
Ferro-molybdenum	0.171	21.1	274.0
"	0.142	12.8	230.0
"	0.096	7.0	150.0

of rust adhering to the charge per ton of steel, about 2.5 cubic metres of hydrogen, that is at 0 deg. C. and 760 mm. Hg almost twenty times the volume of the steel, are offered to the steel bath and are partly absorbed by it.

Absorption of Gas by the Steel from Alloying Materials

It has been emphasised that dissolved gases can only be removed from the steel bath by intensive boiling. For this reason it is necessary to prevent gases from entering the steel bath after the termination of the boiling period. In the production of alloy steels in particular, it is often impossible to avoid adding alloying materials to the steel bath after the termination of the boil. These alloying materials, however, sometimes have a high content of gases and oxides which may exert a detrimental effect on the finished steel if they are added to the highly heated metal bath with its high capacity for dissolving gases.

Table I gives the results of the oxygen and gas analysis of a number of alloying materials, the oxygen content being expressed as a percentage, the hydrogen content in ml. per 100 grms. and the total quantity determined by the vacuum melting method in ml. per 100 grms. It should be pointed out that the highest available experimental figures have been selected in order to show the contents which must be expected in these alloys in unfavourable cases.

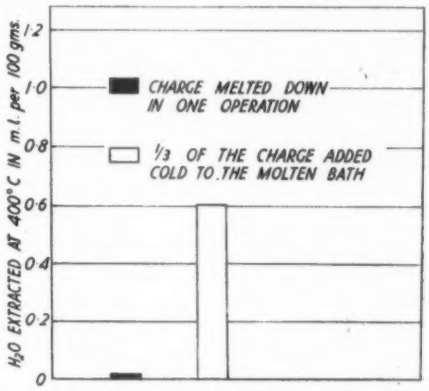

FIG. 5.—INFLUENCE OF MELTING METHOD ON HYDROGEN CONTENT IN MELTING ELECTROLYTIC COPPER.

If, for instance, ferro-alloys having a high hydrogen content are added to the finished steel, even a well deoxidised and killed steel will often become wild when poured and will cause the ingots to rise. This observation may be made even with transformer steel having about 4 per cent. Si if the steel has been alloyed in the ladle with ferro-silicon containing hydrogen.

The effect of the subsequent addition of materials containing hydrogen to a molten bath of metal is clearly illustrated by the following example. Electrolytic copper, which is well known to contain large quantities of hydrogen, was slowly melted in a high-frequency furnace. A ladle sample, when heated in vacuum at 400 deg. C., gave only 0.012 ml. H_2 per 100 grms. of metal. Electrolytic copper to the amount of one-third of the weight of the charge was then added to the molten bath. A fresh sample gave 0.60 ml. H_2 per 100 grms. of metal, *i.e.*, 50 times the amount originally found. The results are shown in Fig. 5. Hydrogen is thus greedily absorbed by the molten metal of high dissolving capacity.

It is therefore seriously recommended that all alloying materials subsequently to be added to the finished molten metal should be previously annealed for expelling the gases. In doing this, care should be taken to see that the treatment takes place at a temperature at which the solubility of gases in the alloy is not very great, preferably at a dull red heat, and in an atmosphere from which the absorption of gases is impossible.

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Personalities at the Congress Banquet

***Top row*: Mr. and Mrs. Lake and Dr. and Signora Vanzetti receiving the guests; Group of Belgian delegates including Mr. R. Deprez and Mr. and Mrs. P. Denis. *Second Row*: Mr. John Lake talking to Mr. J. Ferdinand Kayser; Mr. F. J. Cook, a founder of the Institute, with Dr. Donaldson. *Third row*: Mr. "Dick" Miles and Mr. J. E. Mercer; Mr. Victor Stobie talking to Dr. Vanzetti; Professor and Madame Portevin and Professor Pisek. *Bottom row*: Mrs. Frank Russell; Mrs. H. Winterton; Mrs. A. S. Beech and Mrs. Campion; Mr. and Mrs. Hurst with Dr. Jungbluth.**

Congress Delegates Afloat on the Thames

Top row: The pleasure steamer "Cliveden" leaving Windsor; The after deck. *Second row*: Arrival at Boulters Lock; In the grounds of Windsor Castle. *Second row*: Mr. Lake poses for our camera man; A Polish group occupying the bow. *Bottom row*: m.v. "Royal Princess" arrives at Ford's Wharf at Dagenham; Herr Rotmann and Mme. Bensimon.

Core-Shop Control

By J. J. SHEEHAN, B.Sc., A.R.C.Sc.I.

(*Continued from page 519.*)

Fin Inhibition

However, in addition to a greater cost in binder, there are two other very serious disabilities in the use of this latter type of sand, becoming more serious as the grain size becomes larger. The most troublesome of these defects is an expansion fin, produced on the casting when cores with sand grains of uniform size are used. (All sizes in any one column in the arrangement of sizes already given are considered as a single size, since no fitting-in is possible.)

This defect is shown in Fig. 20, and is represented diagrammatically by Fig. 21. A thin fin of metal is produced at the corners of the casting, which is very difficult to remove in the fettling shop. These figures illustrate the defect produced with internal cores, *i.e.*, cores completely or almost completely surrounded by metal. This defect is also produced with external cores, and is illustrated by Figs. 22 and 23.

While this latter type of fin is easier to dress off, it still necessitates extra work and is otherwise undesirable. An examination of the defect readily showed that it was produced by liquid metal penetrating into a crack in the core, and that this crack was produced by the expansion of the sand. Cores of rectangular section crack at the corners, and cores of circular section crack at the weakest point of the circumference.

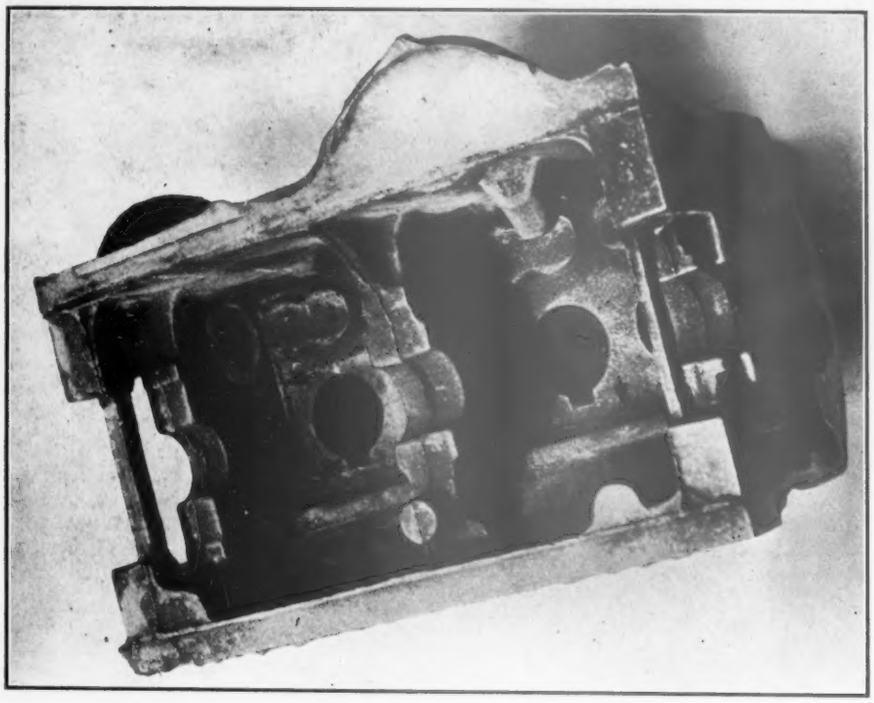

FIG. 20.—FIN DEFECT DUE TO EXPANSION.

In cores made of uniform rounded grains, the flowability of the sand is good, and good compaction is a normal condition. Under these conditions, when expansion occurs, there is no room within the core structure to take up this expansion, and cracking occurs. It can readily be seen, however, that if the sand mass consists of grains of unit size mixed with grains of less diameter than 2/5 unit size, the smaller grains can expand in the voids between the unit sizes. Again, since the surface area of the smaller grains is greater in proportion to the mass than the larger grains, they will heat up more rapidly and expand, reducing at the same time the amount of heat available later to expand the larger grains; in other words, the expansion can take part in stages.

Such a core has within its structure room for sufficient expansion to reduce the tendency to crack, and Fig. 24 illustrates these assertions. No. I is made of coarse uniform-grained sand; No. II is made of fine uniform-grained sand, and No. III is made of a mixture of coarse and fine grained sand. The cores were heated rapidly to a temperature of 800 deg. C., and Nos. I and II show large cracks, whilst No. III is entirely free from cracks.

When the fins produced by these cracks occur on the casting, the trouble and cost of fettling are increased. When the cracks occur in runner cores, erosion of the edge of the crack frequently occurs, and dirty castings are a consequence. The runner core of a bottom-filled steel ingot mould exhibited this defect and was rectified by the additions to the core mass of small grains in the form of silica flour. Fig. 25 shows the condition of the runner before and after this addition.

Influence of Grain Size and Distribution in Green State

Rounded sand grains of uniform size produce in a core which consists entirely of such grains a tendency to sag while in the green condition. This tendency is most marked with large grains. It can be controlled to an extent by using a mixture of grain sizes or by using a fine-grained sand. There are other methods of controlling and eliminating this defect which will be referred to later. Fig. 26 illustrates this tendency to sagging, and the reduction in the tendency when using a blend of sizes, wherein No. I test-piece consists of + 40 mesh sand; No. II test-piece consists of + 100 mesh sand, and No. III test-piece consists of a mixture of + 100 mesh and + 40 mesh sand in those proportions previously found to give the maximum amount of fitting-in, *i.e.*, 66.6 per cent. of the finer material with 33.3 per cent. of the coarser sand.

With the foregoing considerations in mind, it is possible to select sands and sand mixtures for the core shop which will give a maximum in effectiveness with a minimum of cost in materials and in processes, and by using the tabulation of sizes suggested it is possible to regulate the mixtures with some knowledge of the results to be expected.

Core Binders

The selection of core binders is based on the requirements in green strength of the core-sand mixtures and the requirements in dry strength of the finished core. The dry strength is of ultimate importance in the baked and finished core, and offers few difficulties either in the selection or control of materials or processes. The green strength is of importance during the manufacture of the core only. There is a large variety of materials capable of giving satisfactory service, and the final selection is often deter-

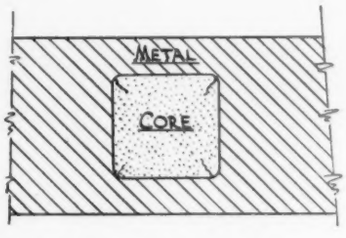

FIG. 21.—CAUSE OF EXPANSION FINS.

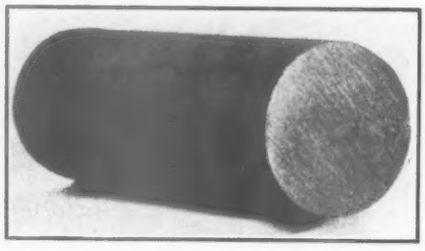

FIG. 22.—FIN DUE TO EXPANSION OF EXTERNAL CORE.

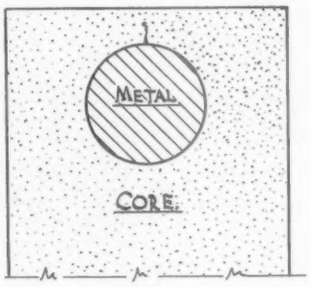

FIG. 23.—CAUSE OF FIN WITH EXTERNAL CORE.

mined by a peculiar condition of the shop or requirement in practice.

The shop condition which most influenced the ultimate selection of green binder was the method of mechanical delivery of the prepared sand mass, and the transportation of the green cores.

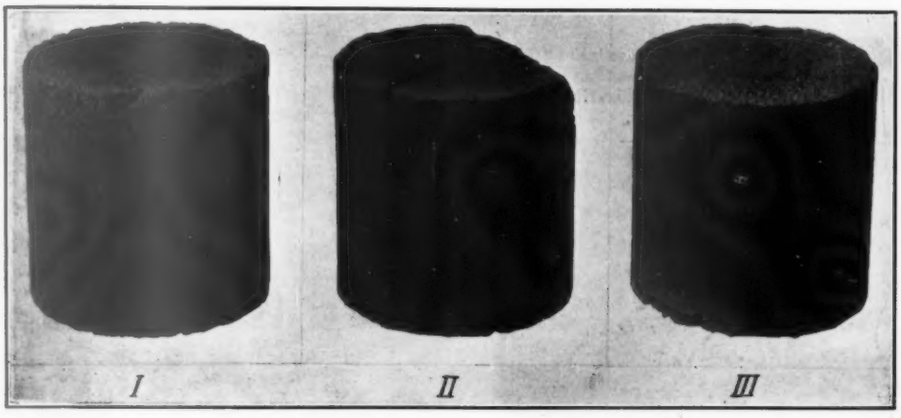

FIG. 24.—INFLUENCE OF CORE MIXTURES ON TENDENCY TO CRACK.

The special requirement was an ashless binder. This latter consideration was necessitated by the intention eventually to install a core-sand recovery plant, and also by the fact that burnt core sand is the base material of the synthetic moulding sand systems now in operation. Any ash would be undesirable under either of these conditions, and a fusible ash particularly so. Molasses and wood-extract concentrates were consequently undesirable, and the ashless cereal binders were indicated.

Transport System

The mechanical transportation of the prepared sand mass consists of an overhead bucket conveyor, shown in Fig. 27. Each bucket holds approximately 70 lbs. of prepared sand. This means that every 6½-cwt. batch of sand milled is divided into 10 smaller lots, exposing a considerable area of the mass to the atmosphere of the shop for periods of time, dependent upon the distance of the core bench from the preparation platform, and the immediate requirements of the core bench. (Should sand not be required on the bench the full buckets continue to circulate and are not tipped until needed later.) These conditions require a green bond that does not readily dry out. The green cores are transported to the drying oven on a tray conveyor of the type shown in Fig. 28.

This is an excellent conveyor of high capacity and speed, but from the nature of the design subject to some vibration. Green cores on a vibrating conveyor are liable to sag. This tendency to sag can be offset to an extent by a selection of the grain sizes of the sand mass, as already mentioned and illustrated, and can be reduced to a further considerable extent if the surface of the green core air-dries rapidly. One conveyor therefore calls for a green bond that air-dries slowly, and the other for a green bond that air-dries rapidly. A balance between these two conditions is, however, possible. The rate of air drying can be maintained between limits suitable to both conditions.

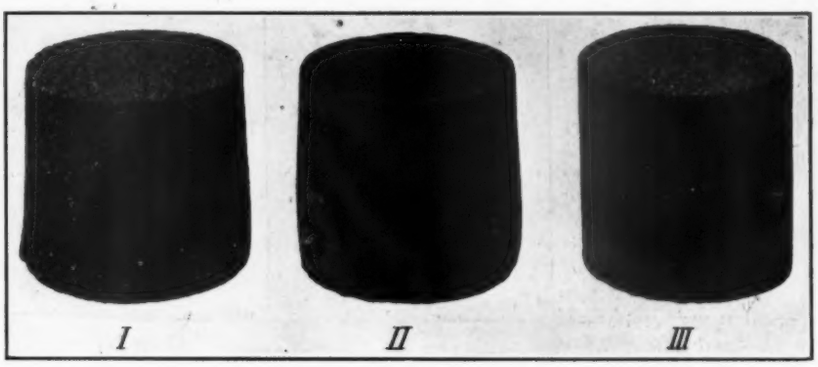

FIG. 26.—TENDENCY TO SAGGING.

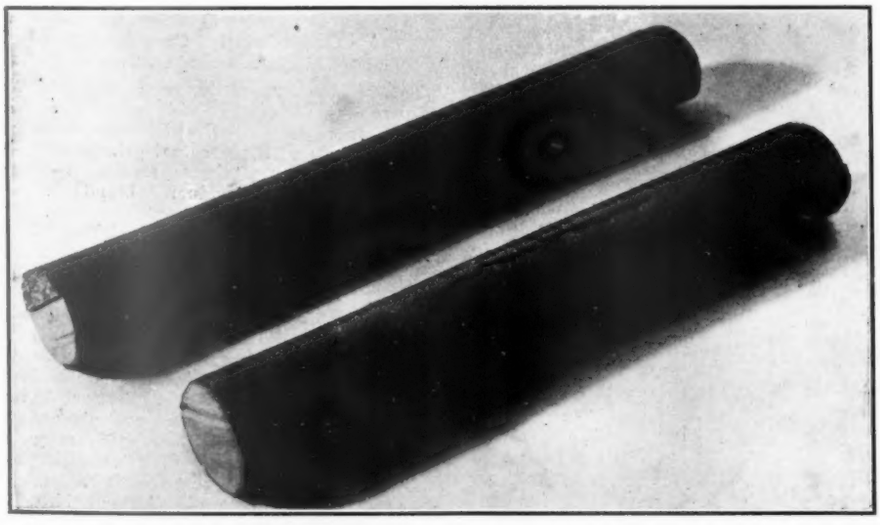

FIG. 25.—ILLUSTRATION OF ELIMINATION OF FINS BY SILICA-FLOUR ADDITION.

Factors in Air Drying

The rate of drying of the mass is dependent upon: (1) The surface area of the sand grains, and (2) the vapour tension of the solution of the binder. (1) is predetermined by considerations of permeability and economy, and (2) is a variable dependent upon the humidity and temperature of the atmosphere of the shop.

The atmosphere of the shop cannot at present be conveniently controlled. The alternative is a control of the vapour tension of the solution of the binder, and this is conveniently obtained by additions of ammonium nitrate. According to Raoult's law, which says: "The diminution of the vapour pressure of a solution of a non-volatile substance is proportional to the number of molecules dissolved in a constant weight of the pure solvent," the control might conceivably be obtained by varying the amount of binder used. This method is undesirable mainly owing to the consequent variation in green strength produced.

The use of an electrolyte is preferable, as it produces no variation in the green strength of the sand mass, and by dissociation produces approximately double the molecular diminution in vapour pressure of substances which do not ionise in solution. The electrolyte selected, as already mentioned, is ammonium nitrate, which has a high solubility and decomposes at the temperature of the drying ovens, leaving no solid residue or ash and assisting to an extent in the oxidation of the unsaturated core oil, particularly in the centre of heavy cores.

The method of control consists in using solutions of ammonium nitrate of varying concentrations to replace the water ordinarily used in the sand mix. Three concentrations are used:—No. 1, with a specific gravity of 1.120—40 per cent. solution; No. 2, with a specific gravity of 1.070—20 per cent. solution, and No. 3, with a specific gravity of 1.035—10 per cent. solution.

The condition of the atmosphere of the shop, *i.e.*, the percentage humidity and temperature and consequent vapour pressure of a water solution under those conditions, is obtained from the wet and dry bulb thermometer, and No. 1, 2 or 3 solution is used according to the indications given.

Control Method

The following is an illustration of the method:—

Read off the percentage relative humidity from the chart accompanying the wet and dry bulb thermometer; subtract from 100, multiply by vapour pressure of water at the air tem-

perature noted, and use No. 1 solution when the resultant is above 8; No. 2 solution when from 5 to 8, and No. 3 solution when below 5.

Example.—

Dry bulb reading 68 deg. Fah.
Wet bulb reading 60 deg. Fah.
Humidity 60 per cent.
Vapour pressure of water at 68 deg. Fah. is 13.1 mm.

$$\frac{100 - 60}{100} \times 13.1 = 5.2.$$

Use No. 2 solution.

FIG. 27.—OVERHEAD BUCKET CONVEYOR.

FIG. 28.—GREEN CORE CONVEYOR.

The resultant may be called the *index of the rate of drying*. It is a direct measure of the amount of unsaturation existing under the conditions noted. A practical method of controlling the rate of air drying without the necessity of wet and dry bulb equipment is of some interest. The green strength of a test-piece is obtained immediately the test core is made and again after a time interval of two minutes. The rate of drying suitable to the shop conditions can be decided upon, and can then be controlled by the use of a suitable strength solution of ammonium nitrate, the equipment necessary being illustrated in Fig. 29. The stripping post in the position shown is an essential part of the equipment. It enables the core to be tested for strength immediately it is made.

The cereal binder used is dextrin; but a soluble starch compound has also been used with success. The operators prefer dextrin, however,

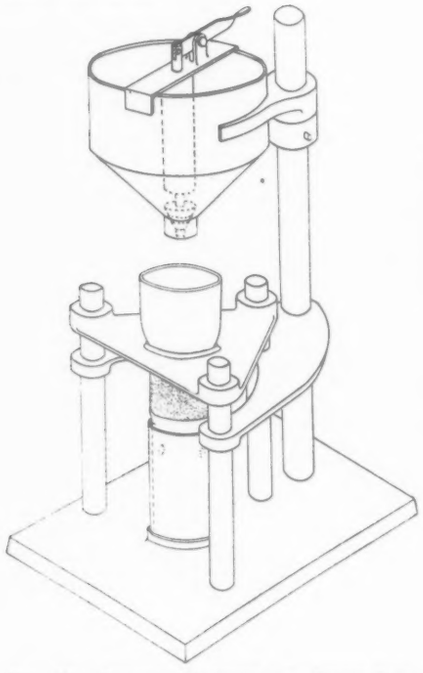

FIG. 29.—TESTING MACHINE FOR GREEN-SAND CORES.

mainly because the flowability of the sand made with dextrin is better, and there is less difficulty in ramming intricate cores.

(To be concluded.)

International Congress and Post-Congress Tour

(Continued from page 546.)

to their preparations and arrangements, and the visitors were enabled to see in detail the sections in which each was most interested.

The party was entertained to lunch by Lord Austin and other directors and managers, and after lunch Lord Austin, in welcoming the visitors, gave some interesting statistics relating to the foundries and their management. Lord Austin was thanked by Mr. Erdos of Hungary and by Mr. W. B. Lake, who also thanked his lordship for his interest in and support of the Institute, of which he is an honorary member.

The afternoon visit was to the Soho works of W. & T. Avery. The visitors were fascinated by the examples of early engineering which were exhibited to them, and noted the contrast between these interesting exhibits and the modern production methods employed by the company to-day. Mr. Hanks of Australia expressed the thanks of the visitors.

The ladies of the party were taken on an excursion in Worcestershire by Mr. J. W. Gardom, and all the party, including Mr. Gardom, enjoyed themselves immensely.

In the evening the visitors, to the number of about one hundred, were entertained to dinner by the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen. Mr. A. Tipper (the Branch-President) and Mrs. Tipper received the guests, and Mr. Tipper presided at the dinner and expressed the pleasure of the Branch at the opportunity of entertaining so many overseas visitors. Replies on behalf of the visitors were made by Mr. Lutoslawski (Poland), Mr. Amundsen (Norway), and Mr. Rauterkus (Germany). The dinner was followed by dancing until early Tuesday morning.

On Tuesday morning, June 20, the works of the Midland Electric Manufacturing Company were visited, and at 12.40 p.m. the party entrained for Derby, where another series of works visits and excursions has been arranged.

Publication Received

A Treatise on Toolroom Grinding. Issued by The Carborundum Company, Limited, Trafford Park, Manchester, 17.

This publication, which by courtesy of the Carborundum Company will be sent to our readers on request, is divided into five sections. The first deals with the actual grinding wheels, and it is of interest that use is made of the expression "Carborundum brand silicon carbide." Whilst in this country Carborundum can be the name of a definite mineral entity, yet in the U.S.A. it is a trade-mark. Hence the use of a phrase universally acceptable. The diamond-faced wheels, being a very recent addition to the lines marketed, have not been included, but a special pamphlet on this subject is available. This part not only details standardised shapes, but includes useful hints for the maintenance of wheels. Sections II and III cover the subjects of lathe and planer tools and cutters and reamers. A wide range of miscellaneous jobs is dealt with in Section IV, whilst in Section V types of grinding rather than specific tools are considered, and this probably constitutes the most interesting chapter of all for our readers. It embraces the grinding of cylinders, surface and internal grinding, and notes on the grinding of cast iron. Finally, Section VI is made up of a series of useful tables, such as operating speeds, the various standardised threads, and so forth. The reviewer is convinced that a study of this book will clarify the ofttimes rather hazy notions of just what grinding is and what it can reasonably be expected to perform.

Influence of Repeated Remelting on the Properties of Light Alloys*

By M. HÁJEK† and J. KORITTA‡

In recent years aluminium alloys have been steadily gaining in importance as a material for construction. The reasons for the continually increasing use of this material in machine construction are the demand for light and simple designs of engines, where higher outputs are required, and a number of advantages which the light alloys offer in the direction of mechanical and other properties. The increased production of light-alloy castings demands, under present economic conditions, the solution of the problem of utilisation of foundry scrap.

In this Paper, which is the first part of a more exhaustive study of this problem, the authors attempt to determine the influence of repeated melting on the mechanical properties of cast aluminium alloys.

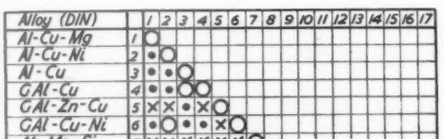

FIG. 1.—GUIDE IN THE MELTING OF ALUMINIUM SCRAP (IRMANN).

In the light-alloy foundry, sometimes more than 50 per cent. of the material melted takes the form of runners, risers, rejects and other foundry scrap, which is added to the new material and so subjected to repeated melting.

Such material is to be divided in two classes:

(1) Material originating in the foundry itself, *e.g.*, runners, risers, rejected castings, and borings from machine shops directly connected with the foundry. Such material, when properly classified, represents metals of known chemical composition and of known quality.

(2) Material purchased from outside sources. The use of this material is always associated with a certain risk, as its quality, even when covered by a guarantee as to chemical composition, may not be satisfactory.

The use of material scrapped during the manufacture of aluminium castings is always a controversial subject. The remelted material is usually considered as inferior and as a material suitable only for second-grade castings to be utilised for less stressed parts. The qualities of remelted aluminium scrap were studied by Irmann,[1] who has given directions for compounding various aluminium alloys. He reached the conclusion that a simultaneous charging of two or more types of aluminium scrap may result in a melt which is practically useless for foundry purposes. Fig. 1 shows, in a graphical form, types of aluminium scrap which may and which must not be mixed in the same melt.

In the literature available to the authors only a few data on the influence of repeated melting of aluminium alloys have been found. Anderson[2] states that the qualities of aluminium alloys are not actually affected by remelting, but in his book, "Secondary Aluminium," he does not substantiate this statement numerically.

Rosenhain and Grogan[3] studied the influence of remelting on the mechanical properties of the commercial aluminium of 99.65 and 98.51 per cent. purity, and they came to the conclusion that this material did not lose any of its mechanical properties after a tenfold melting and rolling.

In order to throw more light upon this question, the authors studied the influence of repeated melting on the following four standard aluminium alloys:—

Aluminium-copper alloy, designated ... **A**
Aluminium-copper-zinc alloy, designated... **B**
Aluminium-silicon-copper alloy, designated **C**
Aluminium-silicon-magnesium alloy, which in the as-cast condition is designated D_1 and in the heat-treated condition is designated ... ... D_2

The chemical compositions of these alloys are given in Table I.

TABLE I.—*Composition of Alloys used for Testing.*

Designation.	Si. Per cent.	Cu. Per cent.	Fe. Per cent.	Zn. Per cent.	Mn. Per cent.	Mg. Per cent.
A ..	0.18	8.12	0.27			
B ..	0.58	4.26	0.25	5.80		
C ..	12.42	0.89	0.35	—	0.28	
D_{1-2} ..	12.90	—	0.28	—	0.42	0.25

The alloys were melted in coke-fired Morgan furnaces in graphite crucibles. For the first melt only pure metal was charged. The alloys A and B were prepared from aluminium of 99.69 per cent. purity, the alloys C and D were used as delivered by the manufacturers.

For each melt 100 kg. (220 lbs.) of material were charged. No flux was used during the melting process as its influence on the quality of aluminium alloys is doubtful. The fluxes currently used do not have a decisive influence on the reduction of the aluminium oxide on account of the high oxidation temperature of the aluminium. Moreover, the current practice involves the danger of hydrogen absorption in the melted metal when moist fluxes are added to it. Another reason for avoiding the use of fluxes was the desire to prevent any factors influencing the results of the repeated melting.

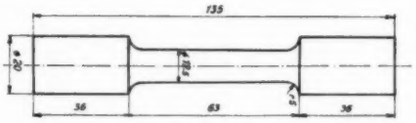

FIG. 2.—TEST-PIECE FOR TESTING OF REMELTED ALLOYS.

The alloys A and B were cast at the temperature 730 deg. C. measured by means of a iron-constantan thermocouple. The melting of alloys C and D was carried out according to the recommended procedure, *i.e.*, refinement by means of sodium and sodium fluoride at 760 deg. C. and casting at 730 deg. C.

From each melt of alloys A, B and C, nine tensile test-pieces were cast in green sand. The diameter of the test-piece castings was 12.5 mm., their test length was 50 mm. (2 in.). The dimensions of the test-piece are shown in Fig. 2.

From each melt of alloy D, eighteen test-pieces were cast. Nine of the test-pieces of this alloy were tested in the "as-cast" condition (D_1); the other nine were subjected to a heat-treatment consisting of heating to 530 deg. C. for 3 hrs., quenching in cold water and annealing at 175 deg. C. for six hours (D_2).

In addition to the test-pieces some intricate green-sand castings were produced from each melt and of each material to determine the susceptibility of the alloys to cracking and faults due to shrinkage.

TABLE II.—*Tensile Properties of Repeatedly Remelted Alloys.*

Number of melts.	Average tensile strength. Tons per sq. in.	Average elongation. Per cent.	Scattering of results in percentage of the average tensile strength.
Alloy A.			
1 ..	10.4	1.5	−11.4 +20.2
2 ..	10.3	1.9	−22.0 + 7.0
3 ..	10.6	2.3	− 9.0 + 9.1
4 ..	10.6	2.2	− 1.0 + 3.2
5 ..	9.0	1.1	− 4.5 + 3.5
6 ..	10.2	1.9	− 3.5 + 3.5
7 ..	9.6	1.8	− 2.6 + 1.8
8 ..	9.3	1.5	− 3.5 + 2.6
9 ..	9.8	1.9	− 7.0 + 5.3
10 ..	9.0	1.7	− 2.6 + 2.6
Alloy B.			
1 ..	10.2	2.4	− 3.7 + 2.5
2 ..	10.7	3.5	− 4.2 + 4.2
3 ..	11.4	3.3	− 4.2 +14.3
4 ..	10.7	2.3	− 6.3 + 2.4
5 ..	9.8	2.0	− 6.4 + 4.2
6 ..	9.5	2.4	− 5.4 + 8.3
7 ..	8.5	2.1	− 7.2 + 5.3
8 ..	9.7	3.2	− 3.6 + 4.2
9 ..	9.8	2.6	− 3.6 + 1.8
10 ..	9.5	2.0	− 3.6 + 3.6
Alloy C.			
1 ..	12.3	4.8	− 5.6 + 5.2
2 ..	12.6	5.6	− 5.0 + 3.5
3 ..	11.9	5.0	− 6.7 + 3.2
4 ..	11.4	4.8	− 5.6 + 3.3
5 ..	11.2	3.9	− 1.1 + 2.3
6 ..	12.7	5.8	− 1.0 + 1.6
7 ..	11.9	6.0	− 5.3 + 2.1
8 ..	12.4	4.7	− 0.5 + 1.0
9 ..	12.5	6.5	− 1.0 + 1.0
10 ..	12.0	4.2	− 9.0 + 4.2
Alloy D_1.			
1 ..	10.3	1.6	− 1.2 + 1.2
2 ..	10.7	1.8	− 1.8 + 1.8
3 ..	10.7	1.6	− 4.7 + 5.3
4 ..	10.9	1.6	− 0.6 + 1.2
5 ..	10.7	1.5	− 1.8 + 3.6
6 ..	11.0	1.6	− 3.5 + 2.3
7 ..	10.8	1.3	− 5.9 + 2.4
8 ..	10.6	1.3	− 1.8 + 1.8
9 ..	10.7	1.3	− 1.2 + 3.6
10 ..	10.5	1.0	− 1.2 + 0.8
Alloy D_2.			
1 ..	18.2	0.6	− 2.8 + 2.5
2 ..	19.5	0.4	− 1.0 + 1.0
3 ..	18.7	0.6	− 2.4 + 3.6
4 ..	18.4	0.6	− 9.6 + 7.0
5 ..	19.8	0.5	− 1.3 + 0.7
6 ..	19.5	0.5	− 5.4 + 4.0
7 ..	18.6	0.4	− 2.0 + 3.1
8 ..	18.5	0.4	− 2.8 + 1.4
9 ..	18.5	0.4	− 2.1 + 2.0
10 ..	17.7	0.4	− 7.5 + 5.4

The test-pieces were machined to 12 mm. diameter and then tested. The broken test-pieces, risers and experimental castings were then used for the next melt, which was carried out exactly in the same way as the preceding one. The procedure of melting, testing and remelting was repeated altogether ten times with each alloy.

All test-pieces D_2 from all ten melts were heat-treated simultaneously to prevent any possible

* Paper read to the International Foundry Congress in London.
† Foundry Department, Ceskomoravská-Kolben-Daněk Company, Limited, Prague.
‡ Research Department, Ceskomoravská-Kolben-Daněk Company, Limited, Prague.

influence of slight differences in quenching and annealing temperatures.

The results of the tests are set out in Table II. The figures given show an average of nine test results. Despite the fact that cast test-pieces were used, the test results show a noteworthy uniformity. The highest and lowest figures for the tensile strength are shown in Table II as factors of the calculated average tensile strength. In Fig. 3 the results are shown in a graphical form.

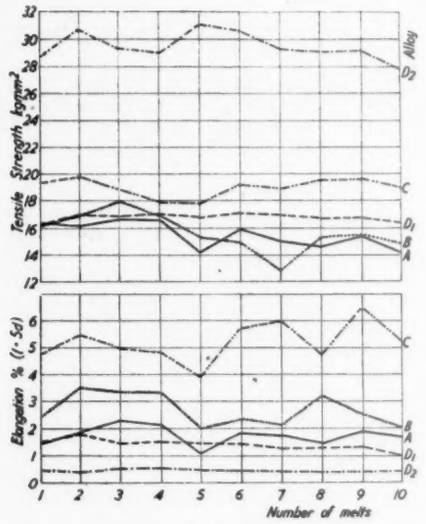

FIG. 3.—EFFECT OF REPEATED MELTING.

The results of the tests show that the repeated melting of the aluminium alloys tested, to which no new material was added, has no marked effect on their quality. The same can be said about the castings produced from the remelted material, which even after ten meltings did not show any inferiority as compared with the castings produced from the first melt. The repeated melting has also no effect on the quality of the heat-treated alloy D_2.

In order to find any possible variation in the chemical composition of the tested material an analysis was made from every first, fifth and tenth melt, the results of which are shown in Table III.

TABLE III.—*Compositional Change after Remeltings.*

Alloy.	Melt No.	Si. Per cent.	Cu. Per cent.	Fe. Per cent.	Zn. Per cent.	Mn. Per cent.	Mg. Per cent.
A ..	1	0.18	8.12	0.27	—	—	—
	5	—	8.12	0.27	—	—	—
	10	—	8.10	0.27	—	—	—
B ..	1	0.58	4.26	0.25	5.80	—	—
	5	—	4.17	0.26	5.73	—	—
	10	—	4.05	0.26	5.27	—	—
C ..	1	12.42	0.89	0.35	—	0.28	—
	5	12.40	0.89	0.34	—	0.27	—
	10	12.54	1.00	0.35	—	0.27	—
D_{1-2}	1	12.90	—	0.28	—	0.42	0.25
	5	13.02	—	0.26	—	0.40	0.29
	10	12.95	—	0.29	—	0.40	0.22

The analyses show that the chemical composition of the alloys, A, C and D practically did not change with the repeated melting. The alloy B containing zinc lost about 0.5 per cent. of its zinc content after ten meltings. The magnesium content of the alloy D was kept in the limits of 0.2 to 0.3 per cent. by addition of small quantities of metallic magnesium to each melt.

It should be emphasised that the tests were carried out under normal foundry conditions and without the use of any surface protection of the melted metal. The test showed that a repeated melting has no harmful effect on the quality of the four aluminium alloys tested. The inferiority of remelted material often experienced in foundry practice has to be ascribed therefore to the use of scrap material of unknown composition or to a lack of care during melting rather than to the remelting itself.

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2 Anderson, "Secondary Aluminium," 1933.

3 Rosenhain and Grogan, "Effects of Overheating and Repeated Melting on Aluminium," J. Inst. of Metals, Vol. XXVIII.

4 Zeerleder, "Technologie des Aluminiums und seiner Legierungen," 3rd edition, 1938.

5 Guertler, "Zum Problem der Aufbereitung von Aluminium-Altmaterial," "Aluminium," 1936, p. 256.

Book Reviews

Etching Brochure. By Dr. Ing. Angelica Schröder, 2nd edition. Published by Gebrüder Borntraeger, 17, Koester Ufer, Berlin, W.35. Price R.M. 1.60.

This is a useful twenty-four page brochure giving in tabular form particulars for the preparation and etching of microsections of steels and a number of non-ferrous alloys. There are also a few paragraphs dealing with the embedding of small samples in low melting point metals, vulcanite and synthetic resin. The metals covered are iron and steel, cast iron, special steels and stainless steel, aluminium and aluminium alloys, antimony, lead and lead alloys, gold and rare metals, copper and copper alloys, magnesium and magnesium alloys, nickel and nickel alloys, silver and silver alloys, tungsten and zinc and its alloys.

Particulars are given of polishing media and polishing speeds and general procedure, followed by complete details of etching solutions suitable for identifying practically all the microconstituents likely to be found in any industrial alloy. From the point of view of English readers it is unfortunate that the author has not given the formulæ of the constituents of the various recommended etching solutions because in its present form the booklet would be of little use to anyone without a considerable knowledge of technical German. It is to be hoped that the author will see her way to put in hand an English translation.

J. F. K.

Introduction to the Study of Heat-Treatment of Metallurgical Products. By Albert Portevin. Published by the Penton Publishing Company, Limited, Caxton House, Westminster, London, S.W.1. Price 22s. 6d.

The essential principles of the heat-treatment of metals are dealt with in such a manner as to enable readers to acquire the fundamental knowledge which such principles involve, mainly by appealing to intuitive ideas or to experimental determinations and facts resulting from observations. In order to do so, certain chapters are followed by supplementary chapters, bearing the same number and marked with a capital A, in which elementary experiments are mentioned and laboratory apparatus is described. These supplementary chapters deal with heat-treatment technique and, while illustrating and supplementing the preceding chapter, also show the connection between given facts and actual use.

The heat-treatment of steel is dealt with in seven out of ten chapters of the book and covers such points as recalescence, preliminary treatment, hardening, tempering and annealing, particular attention being given to the phenomena and mechanism of hardening. Cast iron is discussed in a chapter under the heading of malleablisation of cast irons, which considers not only malleablisation processes, but also the annealing of grey iron castings in order to soften them or to release internal stresses. Consideration is also fully given to the heat-treatment of light aluminium alloys and the precipitation hardening of such alloys by quenching and ageing. In a final chapter, the general principles and phenomena of heat-treatment which have been discussed in detail in regard to steel are dealt with in relation to other alloys susceptible to heat-treatment.

J. W. DONALDSON.

(*Continued at foot of next column.*)

Delegates to the Congress

SUPPLEMENTARY LIST

In addition to the names of the delegates to the International Foundry Congress which were published in the JOURNAL for June 8, the following also registered to take part in the Congress.

Great Britain

Mr. C. R. Austin; Mr. E. H. Brown; Mr. J. N. Burns; Mr. A. Carr; Mr. R. Causebrook; Mr. A. Clarke and Mrs. Clarke; Mr. S. Cooper; Mr. W. C. Devereux; Mr. A. V. Edwards; Mr. R. E. Gresham; Dr. W. T. Griffiths and Mrs. Griffiths; Mr. E. K. Hancock; Mr. B. B. Kent and Mrs. Kent; Mr. E. Longden and Mrs. Longden; Mr. A. D. G. McBean; Mr. K. Headlam-Morley; Mr. E. Noble; Mr. J. M. Primrose, Mrs. Primrose; Miss Robertson; Mr. E. L. Rhead; Dr. J. G. A. Skerl; Mr. P. Talbot; Mr. W. Todd; Mr. J. R. Twigger and Mrs. Twigger; Mr. J. W. Wheeler; Mr. C. Zehnder.

Australia

Mr. A. Carmichael; Mr. W. Hanks and Mrs. Hanks; Mr. J. W. Proud.

Denmark

Count Jen Krag Juel Kind Frijs.

Czechoslovakia

Mr. W. Pollitzer; Dr. Z. Taussig.

France

Mr. Ando; Mr. Bontigny; Mr. Buchet; Mr. R. Chavy; Mr. C. Ducros; Mr. Gayraud; Mr. Genestoux; Mr. Grisot; Mr. R. Loiseau; Mr. R. Mende; Mr. E. Maitre and Mrs. Maitre; Mr. Moutte; Mr. Peyrot; Mr. Rocque; Mr. Saint-Denis; Mr. Truelle.

Germany

Dr. P. Bardenheuer; Mr. W. A. Geisler; Miss K. Markman.

Italy

Dr. M. Barigozzi; Mr. F. Bayon; Dr. F. Bondi; Mrs. P. Borletti; Mr. C. Braggio; Mr. R. Cesare; Dr. R. Dupuis; Mr. F. Evasio; Mr. G. Giacomo; Mr. A. Orsenigo; Dr. F. de Thierry; Dr. F. Villain.

Luxemburg

Mr. L. Brasseur.

Holland

Miss M. J. ten Have.

Hungary

Mr. A. Hauser; Mr. G. Kreuzer; Mr. L. Kreuzer.

Switzerland

Mr. A. Collaud; Mr. E. Zuigg.

U.S.A.

Mr. W. R. Bean (Past-President of the American Foundrymen's Association) and Mrs. Bean; Mr. G. W. Cannon; Mr. W. J. Cannon; Mr. G. Cannon; Mr. E. Thalman and Mrs. Thalman.

The Brancepeth Pulverite Works

OFFICIALLY OPENED BY THE SECRETARY FOR MINES

Whilst great advances have undoubtedly been made in the application of gas and oil for heating duties, considered on a heat value basis, coal still remains the cheapest heating medium. Its handicap lies in the fact that burnt in the solid form it lacks the flexibility of control over furnace temperature and atmosphere which is common to gas and oil firing. If, however, the coal can be used in the pulverised form, we retain the economy of the heating media and at the same time secure flexibility in application and the matter of furnace control equal to either gas or oil firing. The advantages of firing with pulverised fuel whilst very generally recognised can, for the most part, only be realised by the comparatively large consumer. The initial cost of a pulverising plant for a small throughput is generally a deterring factor, hence hitherto the use of pulverised fuel has not been within the reach of the small consumer.

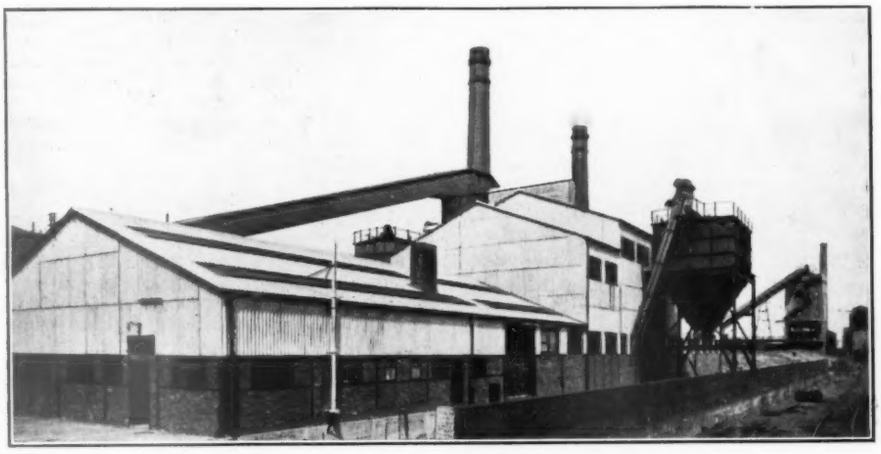


FIG. 1.—GENERAL VIEW OF THE BRANCEPETH WORKS FOR THE MANUFACTURE OF PULVERISED FUEL.

It was a consideration of the foregoing which led to the formation of the Standard Pulverised Fuel Company, Limited, of London, whose objective was the erection of works specially laid out for the production of pulverised fuel on bulk lines. At the outset they were faced with considerable difficulties in the evolution of suitable means of transport as also in the adjustment of railway rates of conveyance. Provision had, of course, to be made for both road and rail transport and ultimately the first-named was provided for by a special tank mounted on a motor lorry from which the fuel can be discharged direct into the hoppers at the consumers' works through a pipeline by the aid of compressed air, the compressing unit being driven from the motor of the lorry. For transport by rail the containers take the form of circular tanks, three of which are mounted on a railway truck and provide for the handling of 15 tons of fuel. The railway companies agreed to standard rates of freightage, providing of course that there should be a proper relationship between load and tare.

It was in 1933 that the Standard Pulverised Fuel Company erected their first plant for the bulk manufacture of pulverised fuel at a Yorkshire colliery and gave to their product the appropriate name of Pulverite, and from the outset laid themselves out for the production of the highest possible grade of product. The fuel is manufactured under strict laboratory control and supplied to a guaranteed specification. The works initiated a new industry and teething troubles had to be overcome. The reduction of coal to a consistent powder is by no means a simple matter, but really a somewhat complex process which calls for skilled care and supervision. The efficiency of the pulveriser is affected by variable factors, such as moisture content, hardness, atmospheric humidity, wear of grinding parts, rate of feed, etc., which have an effect upon the ultimate fineness of the product, but this fineness must be maintained at a constant factor if the fuel is to serve its most usefully economic duty.

With a works laid out solely for the production of a pulverised fuel, every phase of the process has perforce to be carefully studied, because that works must stand or fall by the character of the product it markets. From the outset it was apparent that the new works were meeting a real need, and, whilst the development of the business was perhaps slow, it was certainly consistently progressive. To-day the whole output of the works is going into immediate consumption, and with an ever-growing demand it was determined to build a second works. In the selection of the site consideration had, of course, to be given to the available supplies of coal of the right quality, as also the situation in relation to the consuming centres. The company were fortunately able to acquire a site at the Brancepeth Colliery of Strakers & Love, Limited, Willington, County Durham.

BRANCEPETH WORKS

The Brancepeth Works (Fig. 1), which was formally inaugurated by Mr. Geoffrey Lloyd, M.P., Secretary for Mines, on Wednesday, June 14, contains many interesting features, being designed for the accommodation of two producing units having an output capacity of 1,250 tons of Pulverite per week each, but only one unit has been installed up to the present. The raw coal, which is specially screened, and washed, is taken from the colliery washery by an inclined conveyor to the 600-ton raw-coal storage bunker. The wet raw coal is withdrawn from the base of this bunker by a rotary table feeder and is carried by a second belt conveyor into the works.

The works is divided into five main sections:—(1) Drying room; (2) pulverising room; (3) graded products room; (4) bag store; (5) garage, offices and staff quarters.

Drying and Pulverising Rooms

The raw coal, coming from the storage bunker, is delivered from the conveyor into the wet coal bunker, from the base of which it is fed by a rotary feeder into the coal dryer, which is of the Ruggles-Coles double-tube type and consists of an inclined rotating drum 30 ft. long and 5 ft. dia. (Fig. 2). A gas furnace at the feed end of the dryer generates the required heat for removing the free moisture from the coal and it passes slowly down the rotating dryer while it rotates. The temperature of the dryer is automatically controlled, and the temperatures of both the exit gases and the coal are continuously recorded on thermograph charts.

The dried coal leaving the dryer passes on to the cooling conveyor, which consists of a slow-moving wide belt over which the coal is spread in a thin layer; and this gives the dried coal—which is warm on leaving the dryer—a period of cooling by exposure to atmosphere. On leaving the cooling conveyor, the drying process is completed and the dry coal is then elevated into the dry coal storage bunker, where it remains until it enters the pulverising room.

The dry coal is withdrawn from the dry-coal bunker by a chain feeder, which passes through the wall between the drying and pulverising rooms (Fig. 3), and discharges it into the ball-mill pulveriser, where the coal is reduced to powdered form. The main pulveriser is of the ball-mill air-swept type, and consists of a rotating steel drum carrying eight tons of balls and driven by a 150-h.p. motor. Special classifica-

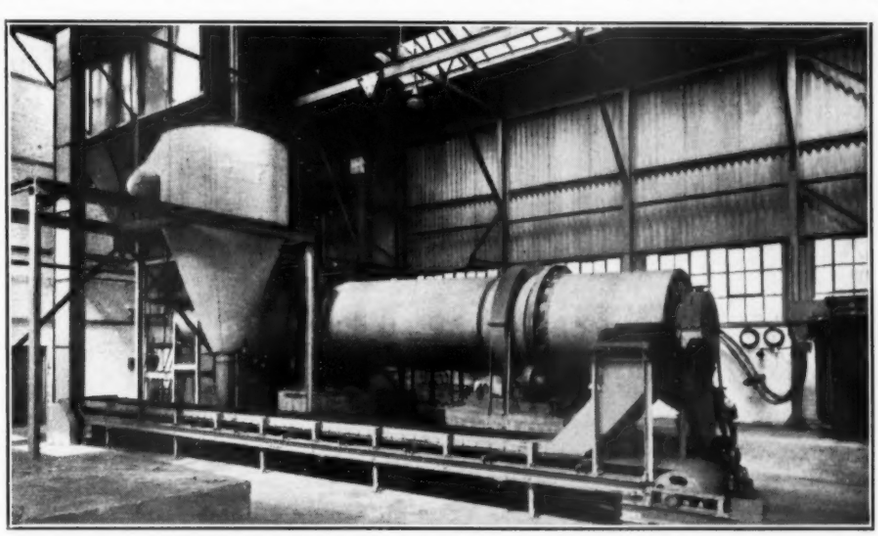


FIG. 2.—COAL DRYER AND DRYING ROOM.

tion arrangements are provided at the discharge end of the pulverising mill in order to ensure that the finished product is maintained to a consistent and accurate specification of fineness.

Classification

Initial classification is effected in the primary separator in the air circuit from the mill, the product from which is deposited into a large cyclone collector. The coarse particles rejected from this separator are removed from its base

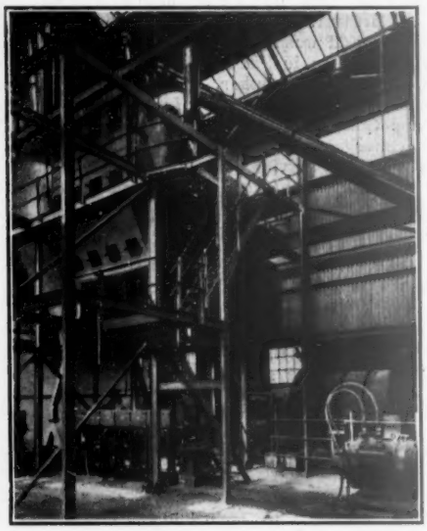


FIG. 3.—GENERAL VIEW OF THE PULVERISING ROOM.

by an elevator and are then subjected to a further classification through two rotary mechanical separators. Here the bulk of the fine coal particles are removed, and the material which is too coarse for inclusion in Pulverite fuel is conveyed back to the feed end of the mill for further grinding. It is interesting to note that the whole system is kept under negative

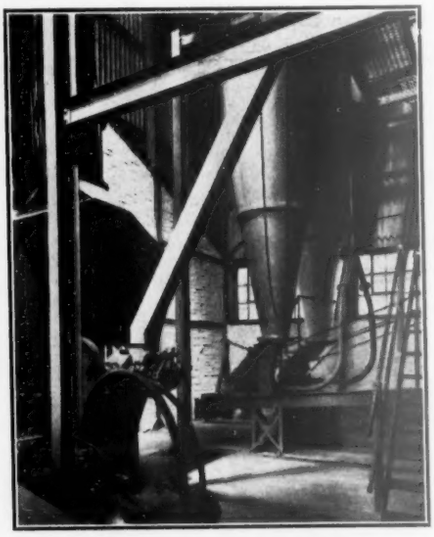


FIG. 4.—VIEW IN THE GRADED PRODUCTS ROOM.

pressure, which prevents any tendency for dust to escape from any part of the plant.

The finished Pulverite fuel is carried from the classifying equipment by two elevators, which pass through the walls on either side of the building, and discharge the fuel into the 150-ton road and rail service bunkers respectively. These bunkers are specially designed with telescopic filling arrangements by which the road and rail tank vehicles can be filled rapidly and cleanly with Pulverite fuel for transport to consumers. The road tank vehicles carry six tons of fuel each, and the rail tankers 15 tons.

Graded Products Room

For the manufacture of special grades of powdered coal, separate equipment is provided in the graded products room (Fig. 4). This consists of a ring roll mill and special classifier, by which the degree of fineness of the product can be accurately regulated. The dry coal is conveyed from the drying room to a dry-coal storage bunker in the graded products room, and the finished product is collected into bins, each of which is fitted with bagging equipment at its base. The products of various grades are packed into four-ply paper sacks containing about 1 cwt. each, and are then stacked, in accordance with their classification, in the bag store.

The works embodies all the latest known developments in the art of producing consistent powders, and is specially designed to conform with the safety Regulations recently introduced by the Home Office regarding the use of machinery for the drying and pulverising of coal.

British Standards Institution

The annual luncheon of the British Standards Institution was held on Thursday last at the Dorchester Hotel, London, Dr. E. F. Amstrong, F.R.S., past chairman of the Institution, in the chair, in the absence of the chairman, Sir Frank Heath, due to ill health. MR. R. S. HUDSON, M.P., Secretary to the Department of Overseas Trade, in proposing the toast of the Institution, said that there was no doubt at all that standardisation had helped to reduce costs and to foster co-operation between manufacturers and consumers. Above all it had helped to solve the problem of making available stocks of spare parts. In that way it had served the double purpose of encouraging the prosperity and utility of United Kingdom industry and of helping to overcome criticism from customers abroad. He had been astounded to see the multiplicity of the various interests which the Institution represented and was glad to find that it was paying particular attention to the problems of the export trade, the work which was being carried out by the Institution was of real national importance.

LORD RIVERDALE said that the British Standard Specifications were intimately linked up with the progress of British export trade. He believed that, given a revival of confidence, the world was on the verge of one of the biggest expansions of trade it had ever seen. "All that is lacking is confidence," he continued. "Invention is here, scientific research is here, in this country we have the finest productive plants, and all are ready to do business if we can get confidence. One of the things that has helped us is standardisation, and we are all grateful to this Institution for the way it carries on its important work."

SIR PERCY ASHLEY, member of the Import Duties Advisory Committee, who had been elected chairman of the Institution, paid a tribute to the efforts of the Institution in the interests of British trade.

Whitehead Iron & Steel Company

The annual report of the directors of the Whitehead Iron & Steel Company, Limited, states that during the year the company have acquired a controlling interest in the engineering and foundry business of W. A. Baker & Company, Westgate Works, Newport. Delivery of the new cold rolling plant against contracts already placed is being made satisfactorily, and the new unit should come to full operation in the autumn. A scheme has been started for modernising the wire mills of the subsidiary company, Whitehead Hill & Company.

Industrial Camouflage

DEFENCE AGAINST AERIAL ATTACK

COLONEL F. J. WYATT, in an address to the Institution of Civil Engineers on June 12, pointed out that the word "camouflage" should really include all stratagems adopted in war to deceive the enemy; he would, however, confine his remarks to the application of camouflage to industrial undertakings.

The purpose of camouflage, he continued, was to make the bombing of a specific target as difficult as possible; that was to say, either to force the enemy to bomb an area rather than a particular target, so wasting bombs, or to cause delay to the bombers over the area, thus giving a better chance to the defence. It was sometimes argued that it was a waste of time to make a target inconspicuous if it were situated near, for example, a river or a railway, which could not be concealed. Raiding bombers, however, would have to travel a considerable distance over country that was unfamiliar, so that anything which made the task of identification harder was worth while.

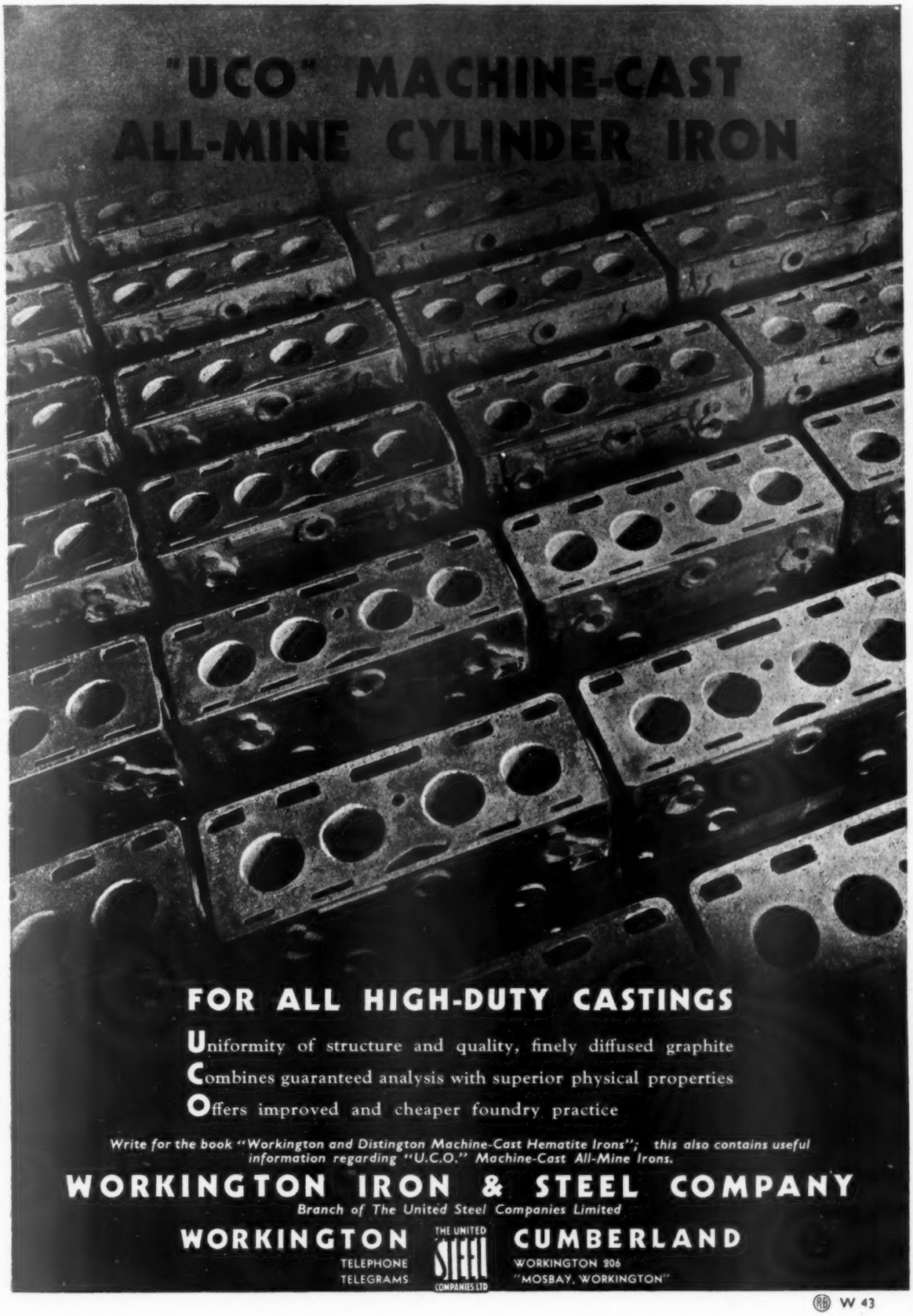
Appearance from the Air

The speaker then went on to consider the difference in appearance from the air between factories and their surroundings; that difference was due to one or more principal causes: (1) The large homogeneous expanses of roof, with their ploughed-field effect due to shadows in the valleys of the roofs; that effect was particularly noticeable in the case of north-light roofs. (2) The shine from roofs, caused by the reflection of light from smooth surfaces; that effect was particularly noticeable when the observer was looking towards the sun. (3) The bulk; an example was the existence of large gasholders, and (4) the regularity of shadow and silhouette; that was specially prominent in the case of oil tanks.

The last effect was probably the most difficult of all to obliterate, and the problem had not been solved completely. There were, in addition, certain othed problems of which no solution appeared to be possible; for example, immense bulk (such as a compact factory covering an area of perhaps a square mile), where the factory was so large that it might almost be said to have no surroundings.

The two main features which had to be dealt with were form, and colour and tone. The form of the buildings should be moulded to suit the surroundings, and their colour and tone should be reproduced; unfortunately, however, there was no generally satisfactory method of measuring tone. The two methods available were imitation and disruption, the former being that where the markings of the factory merged into its surroundings, whilst the latter depended upon the presentation of bold and contrasting patterns, one of which arrested the attention and diverted it from the rest of the form. By suitable painting it might be possible to make quite a large building look like a meadow from one aspect and in one light, but the illusion would disappear when the building was seen from another aspect or in another light, although the meadow might look the same in both cases. The reason was that the structure was three-dimensional, whilst the ground was more nearly two-dimensional. Striking contrasts in tone at corners or ridges would be effective in distracting attention from them, provided that the tones used were in keeping with those existing in the neighbourhood. The addition of excrescences to distort straight lines was also referred to.

With regard to materials for camouflaging, such as paints, the speaker referred to methods of application, and to the mixing of suitable materials with the paint in order to reduce any tendency to shine. The paints themselves had to be durable, and at the same time they had to have a matt finish—two characteristics that were almost incompatible.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The Week's News in Brief

Trade Talk

A CONTRACT valued at £768,000 for the construction of a barrage on the Euphrates to divert flood waters into Lake Habbaniyah has been placed with Balfour, Beatty & Company, Limited, of London.

THE STANTON IRONWORKS COMPANY, LIMITED, now has all its blast furnaces, eleven in number, in full operation, including the two at Wellingboro', which are producing basic pig-iron for the steel trade.

THE MAYOR OF BRIGHTON (Councillor J. Talbot Nanson, J.P.) officially inaugurated on Monday last the second large 37,500-kw. Brush-Ljungström turbo-generator set to be installed at the Southwick Power Station.

TURNER & HICKMAN, LIMITED, have placed orders for two coasting cargo vessels with Scott & Sons, of Bowling. Each vessel will be about 350 tons gross, and will be fitted with Diesel engines of British design.

ORDERS FOR 43 superheated boilers valued at £77,000 have been obtained by the North British Locomotive Company, Limited, Glasgow, from the North Western Railway, Lahore, the largest railway system in India. Part of the work will be undertaken by the Vulcan Foundry, Limited, Newton-le-Willows.

SO THAT they may extend their present iron-foundry at Oakengates, John Maddock & Company, Limited, are in negotiation with the Lilleshall Company, Limited, for the site of the old Snedshill ironworks close to their present works. The Snedshill ironworks were demolished soon after the war, being opened in 1836.

A CONTRACT for an aircraft carrier is shortly to be allocated to John Brown & Company, Limited, of Clydebank. The carrier—the second to be built on the Clyde—will be similar to the 23,000-ton "Implacable," recently placed with the Fairfield Shipbuilding & Engineering Company, Limited, Govan, but will be larger, and will embody greater hangar space.

SINCE the Government's shipping subsidy proposals were announced less than three months ago, shipowners have placed definite orders for nearly 150 cargo ships, amounting to more than 700,000 tons gross. This statement was made by Mr. Oliver Stanley (President of the Board of Trade) in the course of a broadcast last Monday. He added that he knew that still more orders were contemplated.

IT IS LEARNED authoritatively that the Government will shortly exercise compulsory powers to secure possession of the Palace of Engineering, one of the show buildings of the Empire Exhibition at Glasgow last year. The Government desire to utilise this building, and possibly other Exhibition buildings that still remain intact, as a repair and assembly centre for the Air Ministry to serve the Air Force in all parts of the Empire.

A MEETING of Kitchen & Wade, Limited, machine-tool makers, Halifax, is being called to-day (Thursday) to sanction the creation of 125,000 additional 4s. shares, to be offered to shareholders in the ratio of one new share to every five held at 11s. per share to enable the company to acquire all the issued capital in Ormerod Shapers, Limited, machine-tool makers, of Hebden Bridge, now held by the directors of Kitchen & Wade, Limited.

THE NEW LABORATORIES of the British Non-Ferrous Metals Research Association in Euston Street, London, N.W.1, will be officially opened next Thursday afternoon, June 29, by the Rt. Hon. Oliver Stanley, President of the Board of Trade. The Thomas Bolton Memorial will also be unveiled. In the morning the 19th annual general meeting of the Association will be held, followed by a luncheon at the Savoy Hotel, at which Mr. Oliver Stanley will be the principal guest.

POWER TO BUY all scrap iron which might otherwise go abroad is to be given to the Minister of Supply under the Bill setting up the Ministry. This information was disclosed by Mr. Burgin, the new Minister, during the Committee stage of the Bill on Monday. He would also be empowered, he said, to obtain throughout the Empire all supplies of certain raw materials essential for the manufacture of arms. Machinery had already been set up for the administrative arrangement by which close, intimate and continuous contact might be maintained with the Board of Trade in such matters as the purchase of stocks of raw materials. He agreed that there must be something in the nature of a council, board or committee almost continuously in session presided over by the Minister in connection with supplies.

IN CONNECTION with the London Spring Meeting of the Institution of Mechanical Engineers, a section of the Institution with their ladies visited the Fraser & Chalmers Engineering Works of the General Electric Company at Erith, Kent, recently. On arrival at the works the party was received by Mr. F. Lonsdale and Mr. E. A. Pitcher, the joint general managers, and proceeded on a tour of inspection of the various shops, where a wide variety of power house, steelworks, colliery, mining, materials handling and other equipment was in course of manufacture for all parts of the world. Special interest was taken in the turbine shop, where a 20,000-kw., 3,000-r.p.m. G.E.C.-Fraser & Chalmers turbo-alternator set for Darlington Corporation was seen completed and ready for test, while among the machines under construction was a 37,500-kw. turbine for Orlando Power Station, Johannesburg.

AT THE COMMENCEMENT of the foundry holidays in the Falkirk district on June 30, the employees of two ironfounding works will be informed that their foundries will not re-open. These foundries are Abbot's, and Burnbank. The former firm was instituted in 1807 and the latter in 1860. The closing of these foundries is not to be taken as an indication of a decline in trade, because business in the light castings industry in the Falkirk district during the last six weeks has been better than for a considerable period before that, while during that six weeks the moulders' unemployment list has been reduced by fully 500 men. The foundries are closing as the result of recent amalgamations, and it is understood that the employees from Abbot's will be transferred to the Falkirk Iron Company and Callendar Iron Company, while the workers at Burnbank will be absorbed by the Camelon and Grange Foundries. These changes, therefore, will not seriously affect the position of unemployment in Falkirk. Burnbank Foundry was recently taken over by Federated Foundries, Limited, and Abbot's is incorporated in Allied Ironfounders, Limited.

A STATEMENT on the Ministry of Supply Bill made by the Federation of British Industries says that, whilst the Federation supports the institution of such a Ministry, and fully realises the necessity for the exercise of wide authority during a period of emergency, it views with considerable apprehension the powers conferred on the Minister by Clause 2 of the Bill. This clause, which is included among the permanent provisions, seems to the Federation to extend powers of manufacture far beyond those at present held by Government Departments, and to make State trading, as well as State manufacture, possible in a very wide field. Believing that these powers are capable of being used in the future to the serious detriment of private enterprise, the Federation would urge the Government to make these provisions temporary, like those of Part II of the Bill, and to ensure that they be subject to certain safeguards, such as the requirement that any extension of manufacturing powers should receive the affirmative resolution of both Houses. Under Clause 12 of the Bill, manufacturers may be required to give special protection to their plant, and a grant at the rate of 27½ per cent. is to be made toward the capital cost. The balance is to be reimbursed by addition to contract prices, but only to the proportion that the output is taken for Government purposes. In the Federation's view, under these provisions, grave inequities are bound to arise as between one establishment and another. As the sole reason for this special protection is the fact that the firms concerned are engaged on vital Government contracts, the Federation is of the opinion that the Government should itself bear the whole of the capital cost.

Obituary

MR. THOMAS BORTHWICK, who was manager for 25 years of the Consett Iron Company's Crookhall Foundry, at Leadgate, Co. Durham, has died at the age of 65.

MR. A. L. ARNOLD, who died at his home at Hale, Cheshire, last week in his 66th year, was a director of Partington Steel & Iron Company, Limited, and of Pearson & Knowles Coal & Iron Company, Limited.

Personal

MR. HENRY S. LOEBL has joined the board of Vosper, Limited, engineers and ironfounders, of Portsmouth.

THE MELCHETT MEDAL of the Institute of Fuel for 1939 has been awarded to Mr. H. A. Humphrey, late consulting engineer to Imperial Chemical Industries, Limited, for the outstanding work he has done in the development of fuel and appliances in connection therewith.

MR. J. R. GREENWOOD, chairman and managing director of Craven Bros. (Manchester), Limited, has resigned from the boards of the Brush Electrical Engineering Company, Limited, and other companies, so as to leave himself free to devote the whole of his time and attention to the affairs of Craven Bros.

MR. H. J. GORBUTT and Mr. H. E. Harris have been appointed on the board of Platt Bros. & Company, Limited. Mr. Gorbutt will retain his position of this and associated companies, while Mr. Harris will continue to act as controller of purchases to the group of firms forming Textile Machinery Makers, Limited, and sales manager to Platt Bros., general engineering section.

RETIRING AFTER completion of 55 years' service with the Carron Company, Mr. John Oliver, J.P., of Larbert, has been presented by the management and members of the staff at Carron, Glasgow and London with a radio set, suitably inscribed. Mr. Oliver went from the Saracen Foundry, Glasgow, to the Carron Company in 1884, and was employed in the foundry drawing office. During later years he was chief clerk in the cooking and gas departments, and latterly acted as the company's outside representative for all Scotland, Northern England, and Ireland for various lines of cooking apparatus.

Will

CORRIE, J. B., of Ashtead (Surrey) and of Victoria Street, London, mechanical engineer £31,869

Contracts Open

Newcastle-upon-Tyne, June 30.—Eleven 1½-ton fixed head type electric capstans, for the Tyne Improvement Commissioners. Mr. Albert Blacklock, general manager, Tyne Improvement Commission Offices, Bewick Street, Newcastle-upon-Tyne, 1. (Fee £2 2s., returnable.)

Rotherham, June 29.—1,535 yds. of 4-in. and 3-in. dia. cast-iron spigot and socket pipes and special castings, for the Rural District Council. Mr. A. E. Lant, engineer, Council Offices, Moorgate, Rotherham. (Fee £2 2s., returnable.)

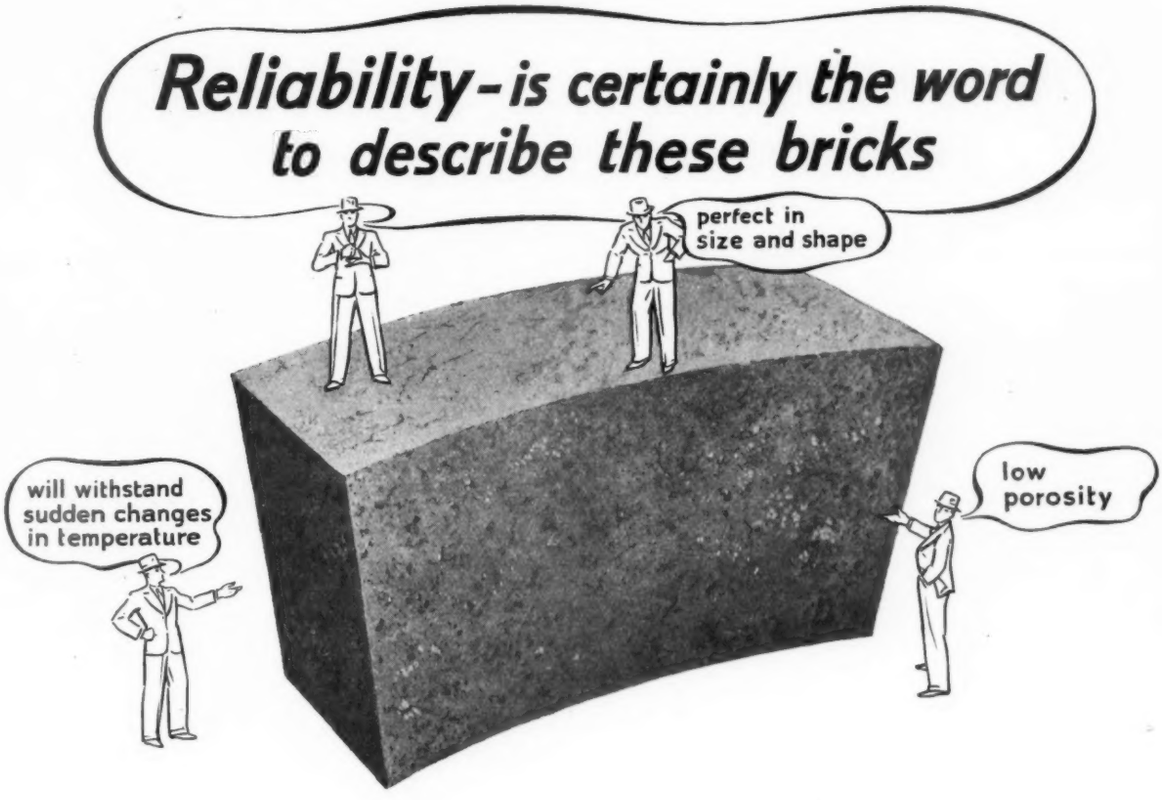
Company Reports

Bradley & Foster, Limited.—Final dividend on the ordinary shares of 4 per cent., making 8 per cent. for the year ended March 31, and a cash bonus of 2 per cent.

Glacier Metal Company, Limited.—Net profit for the year ended February 28, £20,693; brought in, £9,866; to general reserve, £6,000; to income-tax reserve, £3,000; dividend for the year on the ordinary shares of 6 per cent.; carried forward, £9,992.

Whessoe Foundry & Engineering Company, Limited.—Profit for the year to March 31 last, £168,444; depreciation, £7,631; welfare schemes, etc., £2,993; bonus to staff and workmen, £6,000; provision for A.R.P. expenditure, £10,000; investment reserve, £5,000; taxation, £50,389; brought in, £22,146; to general reserve, £25,000; dividend of 40 per cent., £58,000; carried forward, £23,181.

Stanton Ironworks Company, Limited.—Profit for the year ended March 31 last, after depreciation, taxation and contingencies, £507,074; brought in, £484,094; expenses of issue of 4 per cent. debenture stock, £20,488; interest on 4½ per cent. guaranteed debenture stock, £13,997; interest on 4 per cent. debenture stock, £27,413; dividend on the preference shares, £42,611; ordinary interim dividend of 4 per cent. £75,974; to general reserve, £200,000; final dividend on the ordinary shares of 6 per cent., £113,961; carried forward, £492,122. Meeting, June 26.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Raw Material Markets

It has been announced that prices of foundry pig-iron in Scotland have been reduced by 5s. per ton, but no decision has yet been come to with regard to iron in other areas. The demand generally still keeps at a low level and makers are able to carry on with their outputs within narrow compass.

Pig-Iron

MIDDLESBROUGH.—There is only a small day-to-day call for supplies of foundry iron and several producers have ceased to make this type of iron for the time being, as stocks are ample, although some producers have allowed them to fall to quite a low level. Consumers are hoping that makers will reduce existing prices, but it is understood that this is unlikely and that business until the end of September next will be at present prices, which are:—99s. for No. 3 Cleveland G.M.B foundry iron, 102s. for No. 1 foundry, and 98s. for No. 4 foundry and No. 4 forge iron, all less 5s. per ton rebate.

In view of the fact that lower prices for hematite come into operation on July 1, business of late has been quite active. Several consumers had allowed their stocks to fall to rather low levels and consequently have had to accept additional deliveries. Otherwise, however, there has been little doing in this section, which is expected to become quite busy after the turn of the month. In fact, some business for third-quarter deliveries is already reported to have been done.

LANCASHIRE.—Consumers of foundry iron are rather chary of accepting makers' invitations to book over the rest of the year at the present prices, as many are hopeful that lower figures will be introduced in the near future. In any case, there are few users who are in a position to buy far forward, owing to the general absence of satisfactory order-books in the district. For delivery to users in the Lancashire price zone, offers of Staffordshire and Derbyshire brands of No. 3 foundry iron are at £5 4s., with Northamptonshire No. 3 at £5 2s. 6d., and Derbyshire forge iron at from £5 1s. to £5 3s., per ton, according to the class of user. There has naturally been rather a quiet period of trading in the hematite section of late, owing to the imminence of the reduction in price, but it is anticipated that orders will again flow freely after the end of the month.

MIDLANDS.—Trade in high-phosphorus pig-iron continues to be very dull and only small parcels are being taken up at the present time. The demand for light castings is insufficient to maintain satisfactory working time at the makers' plants and a pronounced improvement is required in this section to make the outlook really satisfactory. Works using low-phosphorus iron and hematite are busy and supplies are taken up quite freely, although there has been a quieter tone in hematite since it was announced that prices would be lowered by 5s. per ton at the end of this month. Quotations for low-phosphorus iron are not controlled and the latest figures range from £5 10s. to £6 per ton, delivered Midland stations.

SCOTLAND.—A reduction of 5s. per ton in the prices of foundry iron in this area which came into operation at the end of last week does not seem to have had any immediate effect on the market, which continues to be dull. No. 1 foundry iron is now quoted at 103s., with No. 3 at 100s. 6d., f.o.t. furnaces. It is pleasing to report that certain local founders are working better time, but there is still plenty of room for improvement among the makers of light castings. The demand for steel-making irons continues to be at a good level; hematite mixed numbers are quoted at 120s. 6d., with basic at 92s. 6d., both less 5s. per ton rebate, delivered steelworks.

Coke

There has been rather more forward booking of coke during the past few days, as it has now been made clear in an announcement by the Durham Foundry Coke Producers' Association that there will be no change in the price of Durham coke before the end of the year. Thus, now that consumers have a firm basis on which to operate, it is probable that many users will take the opportunity to secure their future requirements. For delivery to Birmingham and Black Country stations, the minimum quotation for best Durham coke is 50s. 6d. per ton.

Steel

As reported in our last issue, the output of steel in May constituted a record in the annals of the industry; in fact, production has been almost doubled during the past five months. In addition to the extremely heavy pressure for supplies in connection with defence work, there is also an improved demand for steel for commercial users. There was a period two years ago when consumers duplicated their orders as a precaution against deliveries being interfered with, and it is to be hoped that a similar position does not again arise. Steelmakers affirm that they are in a position further to expand their outputs, and if consumers adopt a common-sense attitude and state their real requirements only there should be no question of any interference with supplies to commercial users.

Scrap

It is reported from New York that the International Steel Scrap Cartel has bought about 500,000 tons of steel scrap, which will mostly be for consumption in Britain. A smaller tonnage will be consumed in Poland, it is understood. Meanwhile, there continues to be a shortage of material in this country and it is understood that negotiations are at present proceeding in order to arrange future quotations of steelworks' scrap. The National Federation of Iron and Steel Scrap Merchants and the British Iron and Steel Federation both have different ideas on this question, but it is expected that agreement will be reached in the near future. It is reported that supplies of scrap other than steelworks' varieties are more plentiful in some districts, but the supply position continues to cause some anxiety.

Metals

There has been a slight recovery in the non-ferrous metal markets during the past few days, and although there has not been much improvement in the demand, the tone generally has been firmer.

Copper.—Following the publication of the American Copper Institute's monthly statistics the market improved, the figures being quite favourably received. On the whole, there has been rather more inclination on the part of consumers to buy and quite a good turnover has resulted. During the month of May, apparent world consumption of copper increased by 18,000 short tons to 172,000 tons and the aggregate stocks of refined and blister metal declined by 7,000 tons. The world output of refined copper was higher on the month by 4,000 tons at 170,000 tons; this was due to a heavy increase in American production, which rose 11,000 tons during the month, while ex-U.S. output was 7,000 tons down. The American copper market is now more settled, and although most consumers are not buying ahead, there is quite a satisfactory turnover each day. It is reported from New York that Congress will probably extend the United States import duty on copper of 4 cents per lb. beyond its expiration date of June 30; such a move would meet with general approval among domestic producers.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £41 8s. 9d. to £41 10s.; Friday, £41 10s. to £41 12s. 6d.; Monday, £41 15s. to £41 16s. 3d.; Tuesday, £41 17s. 6d. to £41 18s. 9d.; Wednesday, £42 3s. 9d. to £42 5s.

Three Months. — Thursday, £41 15s. to £41 17s. 6d.; Friday, £41 17s. 6d. to £41 18s. 9d.; Monday, £42 1s. 3d. to £42 2s. 6d.; Tuesday, £42 3s. 9d. to £42 5s.; Wednesday, £42 10s. to £42 11s. 3d.

Tin.—Following the decision of the International Tin Committee to increase the export quota for the third quarter of the year by 5 per cent. to 45 per cent. of standard tonnages quotations on the London market increased substantially. The opinion has since been expressed that an additional 5 per cent. on the existing quota, which amounts to about 800 tons per month, will be inadequate to meet the situation, but tin circles generally are satisfied with the decision. In Amsterdam the raising of the quota is welcomed as a check to over-exports. It is also thought likely that a reduction will be effected shortly in the premiums which Straits tin and some other brands at present command over standard metal. During the past few days business has not been very brisk and the market lost some of its firmness, but steady conditions later prevailed. Prospects for the tin market depend largely on development of the United States position.

Official quotations were as follow :—

Cash.—Thursday, £227 to £227 5s.; Friday, £227 5s. to £227 10s.; Monday, £227 15s. to £228; Tuesday, £228 15s. to £229; Wednesday, £229 5s. to £229 10s.

Three Months.—Thursday, £224 10s. to £224 15s.; Friday, £224 10s. to £224 12s. 6d.; Monday, £224 15s. to £225; Tuesday, £225 to £225 5s.; Wednesday, £225 to £225 5s.

Spelter—Rather quiet conditions have obtained in this market recently and the tension in the Far East has not improved the outlook. There is also the uncertainty regarding the re-formation of the International Zinc Cartel; no control has been exercised over the supply of zinc since the Cartel broke down at the end of 1934. Representatives of zinc producers have recently been conversing in Paris and it is understood that delegates of the Belgium, French, Polish and Empire producers were present.

Daily market prices :—

Ordinary.—Thursday, £13 15s.; Friday, £13 13s. 9d.; Monday, £13 17s. 6d.; Tuesday, £14 1s. 3d.; Wednesday, £14.

Lead.—Consumption on the whole is maintained quite satisfactorily, but the amount of new business at the present time is small. In the United States, there has been an increased demand and producers have raised the quotation by 10 points to 4.85 cents per lb., New York. According to "The Ministry of Labour Gazette," the value of plans for dwelling houses approved in May last in Great Britain was only £3,728,900, against £6,032,000 in May of last year. The total is the lowest in any May for which records are available. The estimated cost of plans for buildings generally, at £7,246,700, shows a decrease of 3.5 per cent. on April and of 19.4 per cent. on May, 1938.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 8s. 9d.; Friday, £14 11s. 3d.; Monday, £14 13s. 9d.; Tuesday, £14 15s.; Wednesday, £14 15s.

Scrap.—Rather quieter conditions have been evident of late and trade demand has been desultory. Most consumers have adequate stocks on hand for the time being and only odd lots are being taken up, generally at bargain prices. There is little doing in the export section.

Approximate selling prices for old metal:—New aluminium cuttings, £71; rolled, £62; cast, £31 to £35; foil, £80. Copper, £38 to £43; braziery, £36. Brass (clean), £22 to £25. Zinc, £9. Lead, £13. Gunmetal, £38.

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